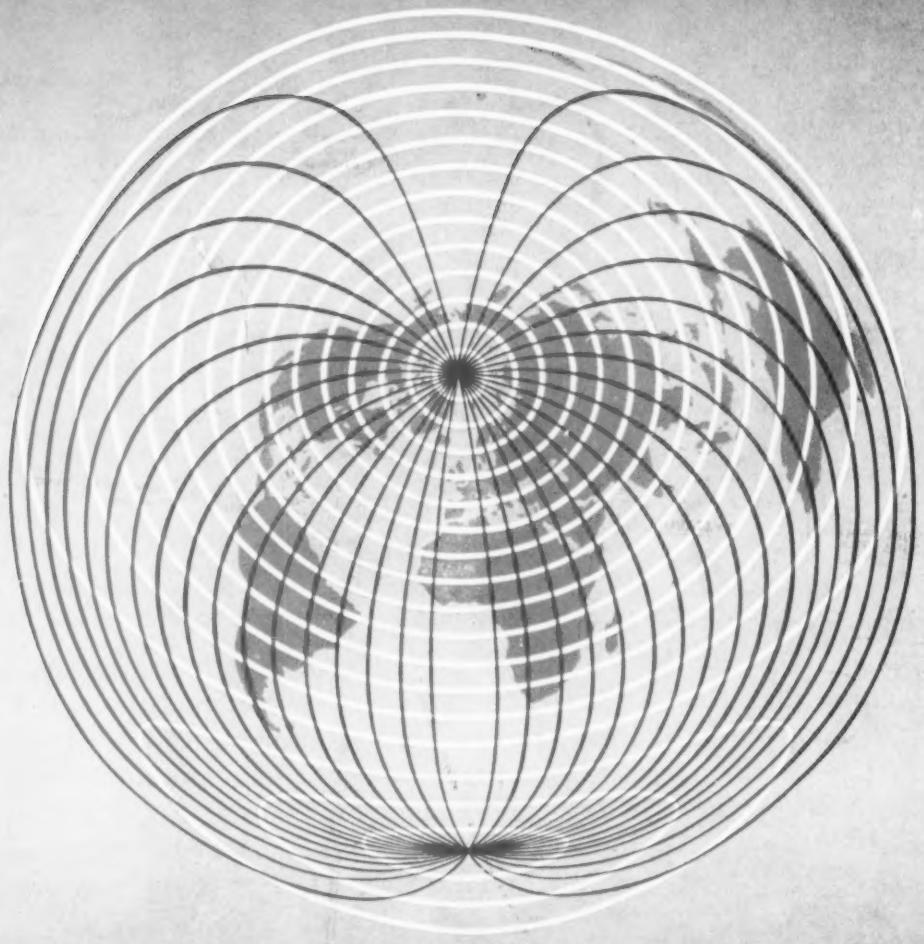
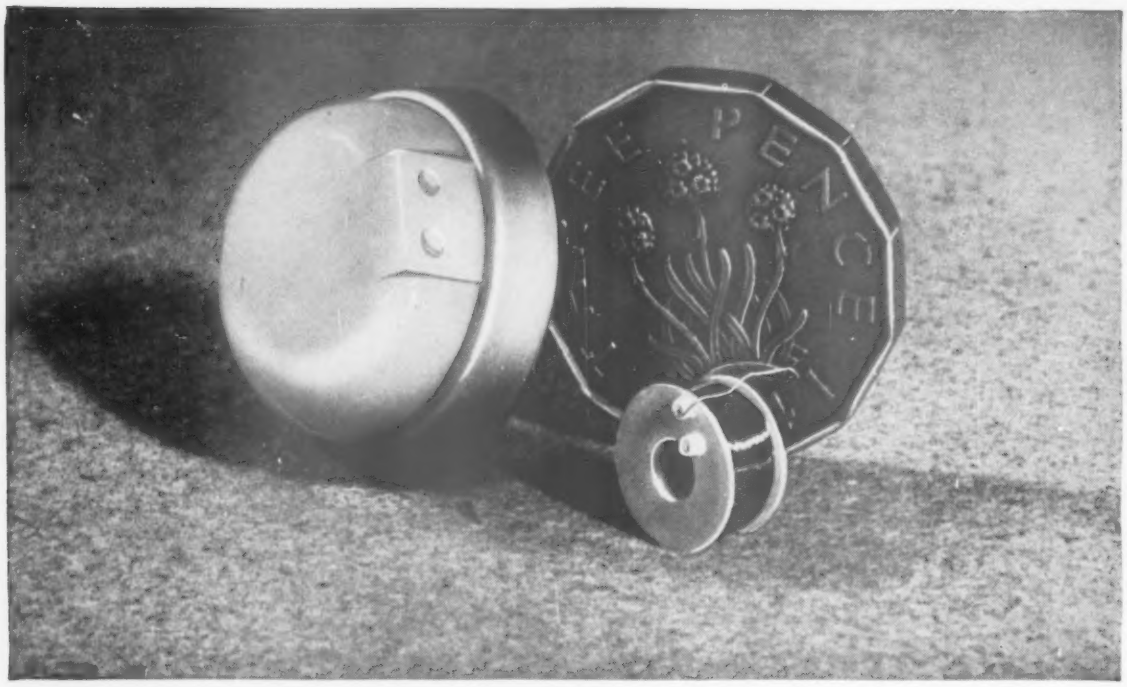
Wireless World

FEBRUARY 1953 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS



WORLD'S SMALLEST 5000-TURN COIL

There are 250 feet of BICC 49 SWG Enamelled Winding Wire in this coil — the smallest 5000-turn coil in the World. Its total weight — including Polystyrene bobbin — is only ·76 grammes!

These coils are used by Messrs. Amplivox Ltd., making their Deaf Aid earphones even less conspicuous than ever. BICC manufacture a wide range of winding wires and strips for every need — from tiny Deaf Aids to heavy-duty alternators and motors. Let us send you further information in Publication No. 266.

B.I. Callender's *Winding Wires*

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2

The PERFECT TEST TEAM

The illustration depicts a set of modern "AVO" testgear being used to measure the "Q" of the secondary winding of the second I.F. transformer on a chassis of unknown characteristics—just one of many tests which can be performed by this combination of instruments.

A signal of predetermined frequency from the "AVO" Wide Range Signal Generator is being fed into the Electronic Test Unit, where it is amplified and fed to the secondary winding of the transformer. The Electronic Testmeter is connected across the tuned circuit under test and from the readings obtained and the controls of the Electronic Test Unit, the "Q" of the circuit can be determined.

The three instruments, shown as a team, cover a very wide field in measurement and form between them a complete set of laboratory testgear, ruggedly constructed to withstand hard usage.

ELECTRONIC TESTMETER

A 56-range instrument combining the sensitivity of a delicate galvanometer with the robustness and ease of handling of an ordinary multi-range meter. Consists basically of a highly stable D.C. Valve Millivoltmeter, free from mains variations and presenting negligible load on circuit under test Switched to measure :—

D.C. Volts : 2.5mV to 10,000V.
D.C. Current : .25μA to 1 Amp.
A.C Volts : .1V to 2,500V R.M.S. up to 2 Mc/s.
.1V to 250V R.M.S. up to 200 Mc/s.
A.C. Power Output : 5mW to 5 Watts.
Decibels : —10db to + 20db. Zero level 50 mW.
Capacitance : .001μF to 50μF.
Resistance : .2ohm to 10 Megohms

Operates on 100-130v. and 200-260v. 50-60 c/s A.C. mains.

ELECTRONIC TEST UNIT

For measuring small values of A.C. voltage, inductance, capacity, and "Q" at radio frequencies. Although designed primarily for use with "AVO" instruments, it can be used with any suitable Signal Generator Valve Voltmeter combination.

As a Wide Range Amplifier, it is capable of an amplification factor of 40 ±2—3db between 30c/s and 20Mc/s

As a Capacity Meter, it covers measurements at radio frequency from .5pF to 1000pF. in two distinctly calibrated ranges.

As an Inductance Meter it gives direct measurements from .5μH. to 50mH. in six ranges.

As a "Q" Meter, it indicates R.F. coil and condenser losses at frequencies up to 20 Mc/s.

Operates on 100-130v. and 200-260v. 50-60 c/s. A.C. mains.

WIDE RANGE SIGNAL GENERATOR

An instrument of wide range and accuracy for use with modern radio and television circuits.

Turret coil switching provides six frequency ranges covering 50 Kc/s. to 80 Mc/s.

Range 1. 50 Kc/s —150 Kc/s.
" 2. 150 Kc/s.—.5 Mc/s.
" 3. 500 Kc/s.—1.5 Mc/s.
" 4. 1.5 Mc/s.—5.5 Mc/s.
" 5. 5.5 Mc/s.—20 Mc/s.
" 6. 20 Mc/s.—80 Mc/s.

Accuracy to within 1% of scale marking. Gives sensibly constant signal of good wave-form, modulated or unmodulated, over entire range. Minimum signal less than 1μV at 20 Mc/s and less than 3μV between 20 and 80 Mc/s. Gives calibrated output from 1μV to 50mV.

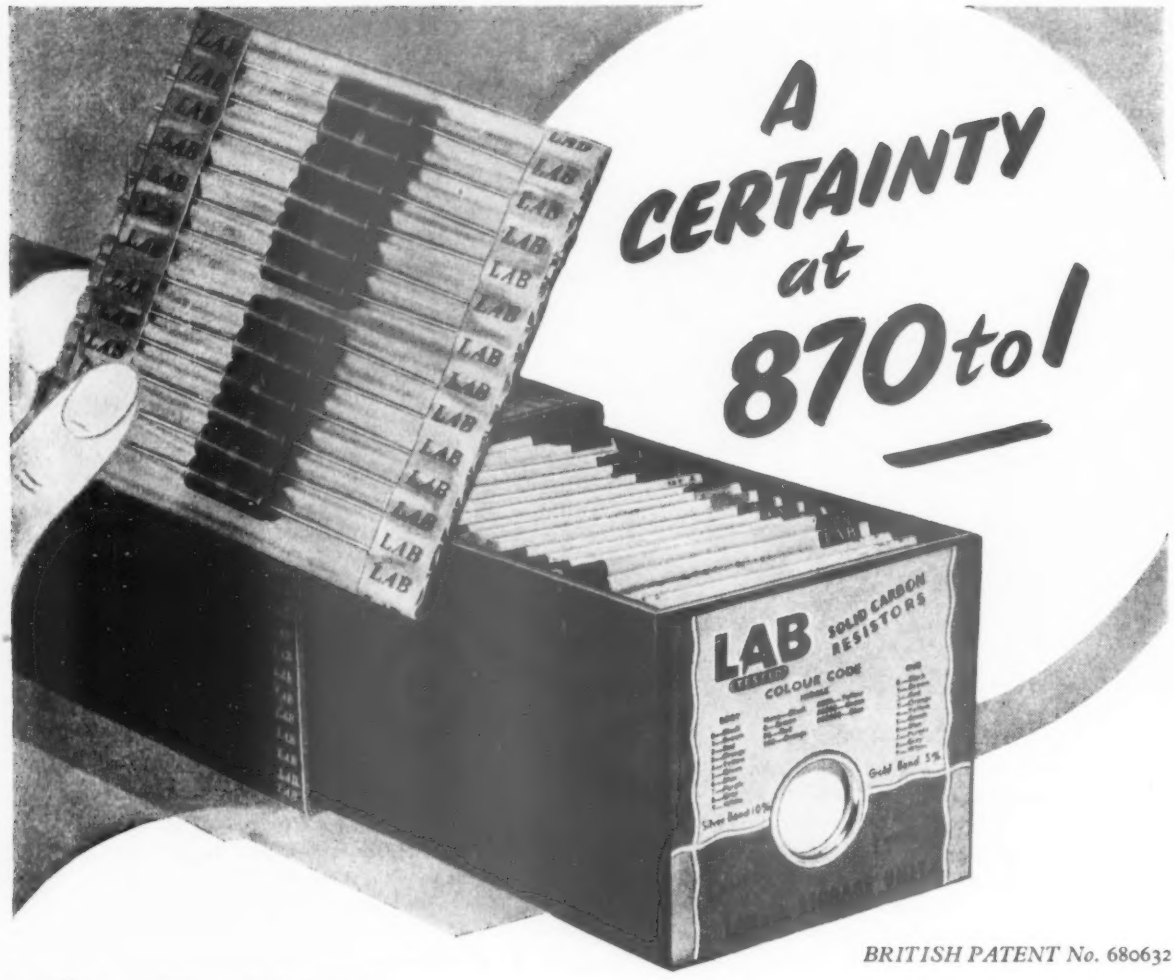
Operate on 100-130v. and 200-26 v. 50-60 c/s A.C. mains.

Battery-operated model also available.

Sole Proprietors and Manufacturers :—

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.

WINDER HOUSE DOUGLAS STREET LONDON S.W.1 *Telephone : VICtoria 3404-9*



BRITISH PATENT No. 680632

The LAB TESTED CONTINUOUS STORAGE UNIT

When you want one particular type and value of resistor you're wanting one in 870, for there are 145 preferred values in two wattages and three tolerances. Yet you can make your choice immediately and with certainty only if your resistors are LABpak'd.

LABpak'd resistors are separately carded in ohmic value, rating and tolerance, and stored, just like a card index, in the LAB Continuous Storage Units. Empty cards are merely replaced with full ones from stock.

There's nothing like the LAB storage unit for speed, accuracy and compactness — and it's FREE with the initial purchase of 180 type 'R' or 240 type 'T' resistors.

The Lab Continuous Storage Units are available from your normal source of supply, but more detailed information can be obtained on request

RESISTOR SPECIFICATION

Ref.	Type	Loading	Max. Volts	Range	Dimensions
T	⅛-watt	⅛-watt	250	10 ohms to 10 megohms	⅜" × 1/16"
R	½-watt	1-watt	500		¾" × ¼"

Tolerance available ±20%, ±10%, ±5%

THE RADIO RESISTOR COMPANY LIMITED

50 ABBEY GARDENS, LONDON, N.W.8 Telephone: Maida Vale 5522

New Standard of Efficiency in a V.H.F Power Tetrode

The Mullard power-tetrode, QY3-125, is the most efficient valve of its class in the world. Its outstanding characteristics include low driving power, low power consumption, and high power gains at V.H.F. With a maximum anode dissipation of 125 Watts, this valve will give an output of 375 Watts up to 120 Megacycles, and 225 Watts up to 200 Megacycles. The QY3-125 is particularly recommended for use as an oscillator or R.F. amplifier in compact communications and allied electronic equipments, operating in the V.H.F. range.

SPECIAL FEATURES

★ Low-inductance Anode Lead — Higher Frequency Performance
★ Double Helical Filament — Low Inductance and Low Hum
★ Bottom Screen Shield — Low Anode/Filament Capacitance
★ Zirconium Coated Carbon Anode — Continuous Gettering
★ Powdered Glass Base — Low R.F. Losses
★ American Giant 5-Pin Base

Full technical details of this and other types in the Mullard range of all-glass V.H.F. valves will be supplied on request to the address below.

PRINCIPAL CHARACTERISTICS OF QY3-125		
FILAMENT	V_f	5.0 V
	I_f	6.5 A
CAPACITANCES	c_{in}	11.2 $\mu\mu$F
	c_{out}	4.2 $\mu\mu$F
	c_{a-g1}	0.05 $\mu\mu$F
LIMITING VALUES	V_a max	3000 V
	p_a max	125 W
	V_{g2} max	600 V
	p_{g2} max	25 W
	I_k max	270 mA
	(full ratings) f max	120 Mc/s
	(reduced ratings) f max	200 Mc/s
BASE		B5F

Mullard

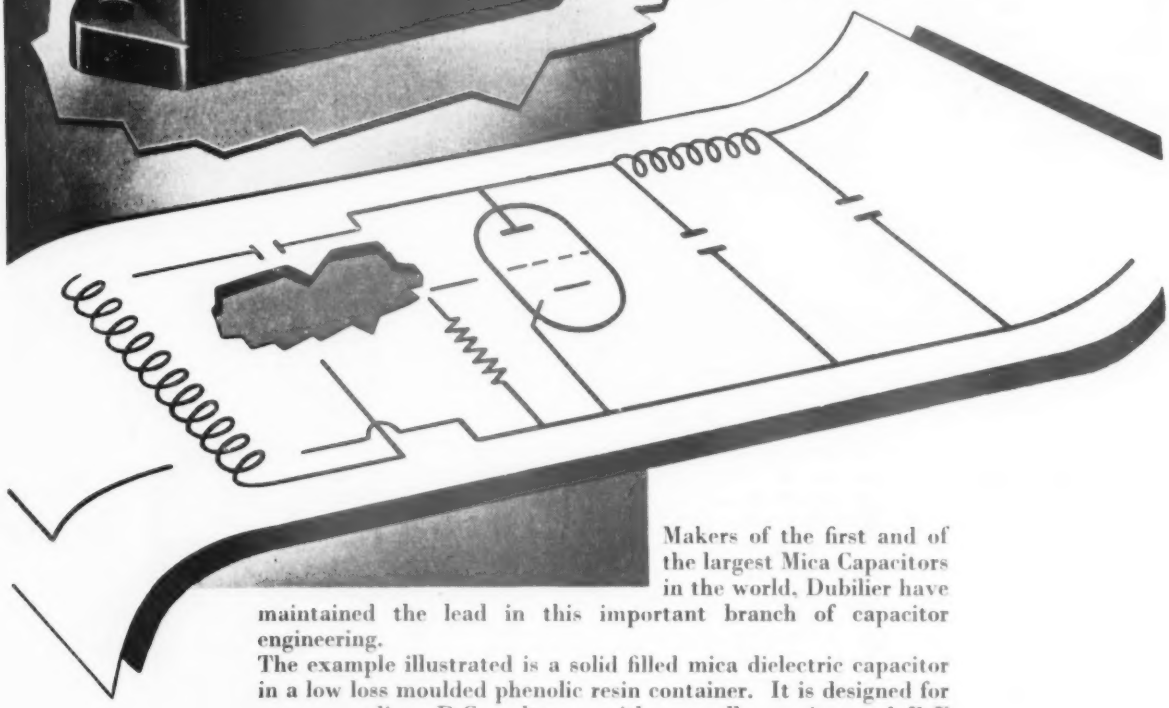
MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, W.C.2.

MVT 115

DUBILIER

MICA DIELECTRIC CAPACITORS

Eminently Suitable for H.F Transmitting and R.F. Heating Circuits



Makers of the first and of the largest Mica Capacitors in the world, Dubilier have maintained the lead in this important branch of capacitor engineering.

The example illustrated is a solid filled mica dielectric capacitor in a low loss moulded phenolic resin container. It is designed for use on medium D.C. voltages, with a small superimposed R-F current, or as the tank circuit capacitor in low power medium and long wave transmitting equipment.

Full details of capacitance values and ratings are available on request.

DUBILIER CAPACITORS

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA RD., NORTH ACTON, W.3.

Phone: Acorn 2241 (5 lines). Cables: Hivoltcon, London. Marconi International Code. Grams: Hivoltcon, Wesphone, London

The Vital Link . . .

. . . upon which the pilot's safety depends is the consistent functioning of his radio and radar equipment. One dry or H.R. joint among the thousands of soldered joints in these precision instruments may mean the failure of a whole circuit endangering both pilot and machine.

FAULTLESS FLUXING PRESERVES THE VITAL LINK

Dry or H.R. joints are impossible with Superspeed for the flux is always released in exactly the correct proportion. This faultless fluxing action is achieved by the unique STELLATE core which gives six points of rapid solder collapse. At soldering temperature the activated rosin flux is released immediately for effective spreading and wetting. Superspeed is being used more and more in the production of service equipment where faultless joints are essential.

Superspeed

"WHITE FLASH" ACTIVATED ROSIN-CORED SOLDER

for general electrical, electronic and telecommunication work and all standard uses. A.I.D. and G.P.O. approved. Complies with M.O.S. Specification DTD 599. In all standard tin/lead alloys, 10-22 s.w.g. Sample of Superspeed and the comprehensive Superspeed booklet gladly sent on request. Technical advisers are available for free consultation.

MANUFACTURED BY THE **ENTHOVEN** GROUP

* Marketed by Enthoven Solders Ltd., Enthoven House, 89, Upper Thames Street, London, E.C.4. *

E3405

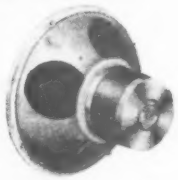
GOODMANS

AUDIOM LOUDSPEAKERS

AUDIOM 60
15 watt

This 12-inch single cone, medium heavy duty reproducer has an outstanding smoothness in response and performance and meets the most modern demands in the field of P.A. installations, small cinemas, high power radiograms, etc.

SPECIFICATION Overall Diameter 12⅛in. Overall Depth 7in. Voice Coil Diameter 1¼in. Fundamental Resonance 75 c.p.s. Voice Coil Impedance 15 ohms. Power Rating 15 watts peak A.C. Flux Density 14,000 gauss. Total Flux 158,000 Maxwells. Nett Weight 12lb. 13oz. Finish Grey Rivelling Enamel.



AUDIOM 70
20 watt

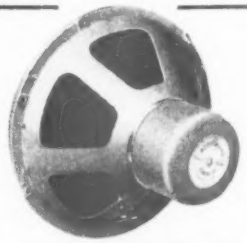
This high power version of our well-known Audiom 60 is available as a bass unit for multi-speaker systems or general Public Address use.

SPECIFICATION Overall Diameter 12⅛in. Overall. Depth 7in. Voice Coil Diameter 1¼in. Fundamental Resonance. Cone Type "1205" 75 c.p.s. (Designed for Public Address use): Cone Type "1206" 55 c.p.s. (Designed for Bass Reproduction). Voice Coil Impedance 15 ohms. Power Rating 20 watts peak A.C. Flux Density 17,500 gauss. Total Flux 195,000 Maxwells. Net Weight 18lb. 4oz.

AUDIOM 80
25 watt

Ideally suited for Dance Halls, Rinks, Cinemas, Electric Organs and very heavy duty Public Address Installations, this powerful Loudspeaker has a remarkably smooth response up to 6,000 c s.

SPECIFICATION Overall Diameter 15in. (38 cms.). Overall Depth 8⅜in. (21.3 cms.). Voice Coil Diameter 2in. (5 cms.). Fundamental Resonance: Cone type 1501, 60 c.p.s. Cone type 1502, 40 c.p.s. Voice Coil Impedance 15 ohms at 400 c.p.s. Power Rating 25 watts peak A.C. Flux Density 14,500 Gauss (nominal). Total Flux 215,000 Maxwells. Nett Weight 25½lb. 11.7kg.



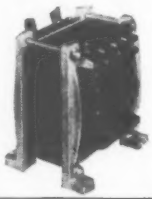
AUDIOM 90
50 watt

Massive construction throughout enables the Audiom 90 to withstand continuous handling of heavy duty inputs, suitable for use in Cinematograph installations, Electric Organs and very high power Public Address systems.

SPECIFICATION Overall Diameter 18in. (45.7 cms.). Overall Depth 10¼in. (25.4 cms.). Voice Coil Diameter 2½in. (6.35 cms.). Fundamental Resonance 25 or 50 c.p.s. Voice Coil Impedance 6 ohms. Power Rating 50 Watts Peak A.C. Flux Density 14,500 Gauss. Total Flux 267.000 Maxwells. Nett Weight 29½lb. 13.4Kg.

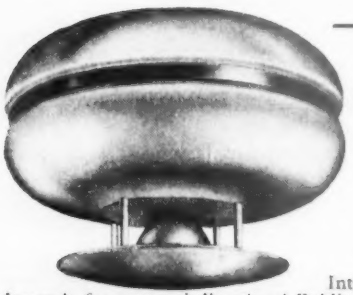
HIGH FIDELITY

Mounted in heavy die-cast clamps and fitted with insulated terminals, the transformer is of robust construction and conforms to the highest standards of electrical engineering.



OUTPUT TRANSFORMER
MODEL H6

SPECIFICATION Peak A.C. 30 Watts. Frequency Range 10-20,000 c/s. ± 1db. Size 3in. × 3½in. × 4¾in. Nett Weight 5lb.



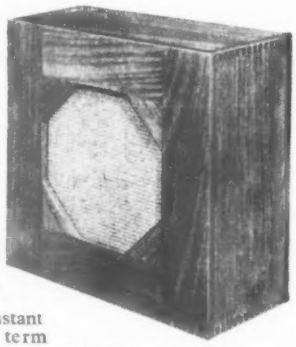
THE CONCENTRIC DIFFUSER
MODEL CD77

Omni-directional P.A. Reproducer

Introduced to meet the demands for an omni-directional Public Address Reproducer, this 10 watt diffuser utilises a high flux P.M. Loudspeaker. The design features besides being of an attractive nature also ensure sound distribution over a radius of 360°.

SPECIFICATION Overall Diameter 20½in. Overall Height (including eye suspension attachment) 17½in. Speaker Unit 10in. P.M. High Flux. Voice Coil Impedance 3 or 15 ohms. Maximum Power Input. 10 watts peak A.C. Net Weight 21 lb.

INDUSTRIAL CABINET No. 5



Strongly constructed of natural polished seasoned mahogany the aperture is covered with a woven cord material ensuring maximum protection to the diaphragm with minimum obstruction to sound. Built with locked corners to withstand the constant handling involved in short term linework the cabinet dimensions have been carefully planned for use with a 12in. P.M. loudspeaker and is ideal also for permanent institutions.

SPECIFICATION Size: 17in. × 17in. × 8¾in. Finish: Natural, Polished. Nett Weight: 9lb. 14oz.

Write for illustrated Data Sheets and full Descriptive Literature to:

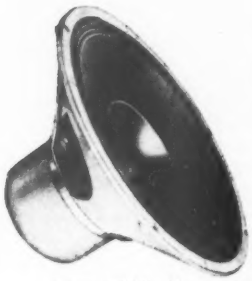
GOODMANS INDUSTRIES LIMITED

Axiom Works, Wembley, Middlesex. *Telephone: WEMbley 1200. Telegrams: Goodaxiom, Wembley, England*

THESE AXIOMS

are not just loudspeakers—
but loudspeakers with a *difference!*

There are four in the family, all differing in specification but possessing a common link—the ability to reproduce faithfully. Several years ago we designed the AXIOM 150 (12in.) which is remembered by tens of thousands of enthusiasts throughout the world. This instrument was acclaimed as "the speaker with a performance far in excess of its price."



Axiom 150 Mk. II

With the advent of wide range recording technique and continuous progress in the design of audio equipment (our congratulations to all concerned) we recognised these advances with the introduction early in 1952 of the AXIOM 150 Mk. II. This 15-watt Reproducer with a frequency range of 30-15,000 c/s. combined with an outstanding transient handling capability gives superlative quality for **£14/13/4,** including purchase tax.

What has been said of the AXIOM 150 Mk. II applies even more to the AXIOM 22 Mk. II (12in.). This is a 20-watt AXIOM with a higher flux density than the AXIOM 150 Mk. II, and an improved transient response due to increased magnetic damping.

Price **£20/19/9,** including purchase tax.

Axiom 22 Mk. II

When these units are adequately housed, Mr. Enthusiast may have to convince Mrs. Enthusiast that the space occupied is merited! Domestic difficulties of this nature can be entirely avoided by installing one of the latest additions to our AXIOM family—namely the 8in. AXIOM 101 or AXIOM 102.

Both these units will handle 5 watts of audio power, which we have found quite adequate for normal domestic levels. For their size they cover an extremely wide frequency range—40 to 15,000 c/s. Though hard to believe, this is testified by the thousands who have already heard them. The difference between the two models is again one of flux density (AXIOM 101 13,500 gauss and AXIOM 102, 17,000 gauss). When housed in reflex chambers both these units occupy the minimum space.

Axiom 101

AXIOM 101, Price £7.2.9 including purchase tax.
AXIOM 102, Price £10.14.2 including purchase tax.

Axiom 102

In the AXIOM range there is a speaker to satisfy the most critical. We believe that due to our exceptional production and research facilities, and the fact that we are largely a self-contained manufacturing unit, these speakers represent greater value than any others obtainable.

All these models are stocked by the leading dealers, but in case of difficulty, please order direct from us. We invite you to write for further details of any unit. Remember we can give you outlined dimensioned drawings of reflex chambers for all Speakers mentioned.

A TRADITION OF EXCELLENCE · FIDELITY · EFFICIENCY

GOODMANS

GOODMANS INDUSTRIES LTD., Axiom Works, Wembley, Middlesex.

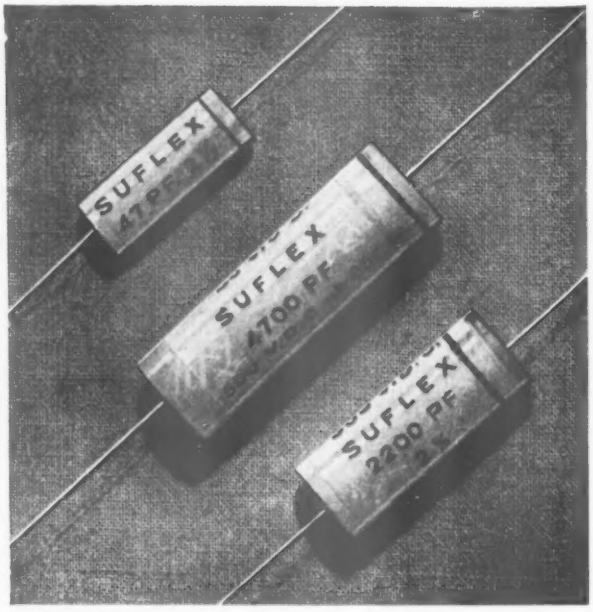
Telephone: WEMbley 1200. Telegrams: Goodaxiom, Wembley, England.

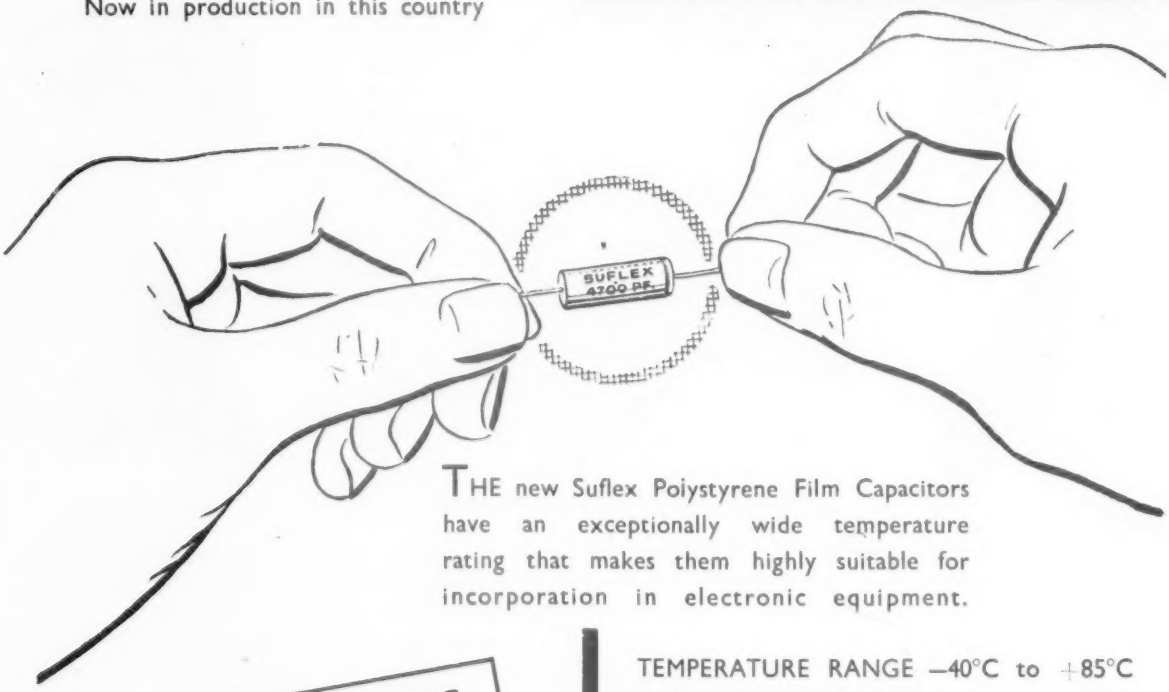
Introducing

SUFLEX Polystyrene Capacitors

Patent applied for

Now in production in this country





THE new Suflex Polystyrene Film Capacitors have an exceptionally wide temperature rating that makes them highly suitable for incorporation in electronic equipment.

SUFLEX Limited
LONDON W.1.

TEMPERATURE RANGE —40°C to +85°C
R.C.S. APPROVED (imported components)

- Available in a range of capacities from 5 PF. to 5,000 PF. Minimum tolerance 1% or 0·5 PF.
- Special values to order.
- *Full particulars and prices on request.*

SUFLEX LIMITED, 35, BAKER STREET, LONDON, W.1, ENGLAND

Grams: Suflex, Wesdo, London. *'Phone: WELbeck 0791-4*

BRITISH and proud of it!

As the world has in the past depended on British inventive genius and craftsmanship in the fields of engineering, shipbuilding, and aeronautics, so it does to-day in electronics—reflected in this new British tape recorder, the Simphonic Model 1A.

Supreme in its class, the Simphonic leads on every count.

PERFORMANCE : Response 50-10,000 c/s. 8 watts high quality push-pull output. Wide dynamic range.

DESIGN : Three motor drive. Monomaster finger tip control. Positive servo brakes on both spools.

FACILITIES : Two running speeds. Twin track operation. Playback via internal or external L/S. Provision for remote control.

STYLING : Handsome, robust portable case. Attractive colour scheme. Provision for carrying microphone, spare tapes and accessories.

SERVICE : British made throughout. Complete established service facilities.

Hear the Simphonic 1A at your local dealer to-day ! Trade enquiries invited.

SIMON SOUND SERVICE

48-50, GEORGE STREET, LONDON, W.1

TELEPHONE : WELBECK 2371 (5 lines)

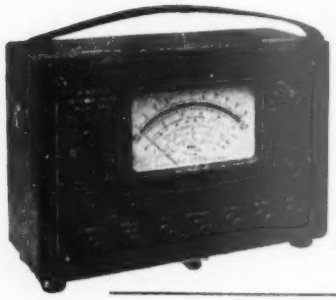
GRAMS : SIMSALE, WESDO, LONDON

CABLES : SIMSALE, LONDON

Strand

Examples from the New range of

TAYLOR INSTRUMENTS



Model 88A Multirange Universal Meter.

20,000 ohms per volt D.C. 2,000 ohms per volt A.C.
5in. scale with knife edge pointer and anti-parallax mirror.
6 scales : Voltage, Current, Resistance, Capacity, Inductance and Decibels. Instantaneous overload protection. Buzzer for continuity testing. Hardwood case, detachable cover, carrying strap.

Volts : D.C. and A.C., 0 to 5,000.
Amperes : D.C.-A.C., 0 to 10.
Decibels : −20 to +69.
Capacitance : 1,000 pF to 100 mFd.*
Complete with leads, prod, etc.

Milliamps : D.C. and A.C. 0 to 1,000.
Resistance : 0 to 5 megohms.
Inductance : 0.2 to 200 henrys.*

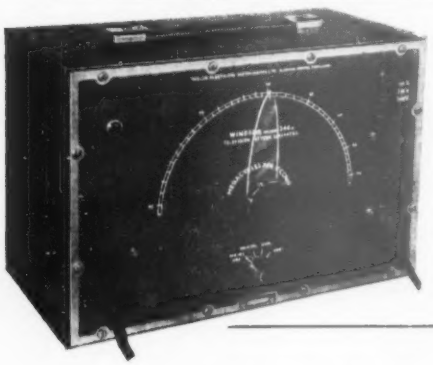
* With external adapter : 313D.

List Price £21.10.0 *Immediate Delivery*

Model 110C Resistance Capacity Bridge.

8 Capacity Ranges from .00012 to 1,200 mfd.
8 Resistance Ranges cover from 0 to 12 ohms to 0 to 120 megohms.
Special comparator scale for checking components against external standard.
Leakage tests on capacitors up to 100 megohms.
Accuracy from 2% to 4% depending on scale and range.

List Price £14.10.0 *Immediate Delivery*



Model 240A Pattern Generator.

A high frequency oscillator covering a range from 40 Mc/s. to 70 Mc/s. with unmodulated or modulated output. Television receivers may be adjusted and set up in the absence of transmission. The modulated output produces white horizontal or vertical bars on the television screen.

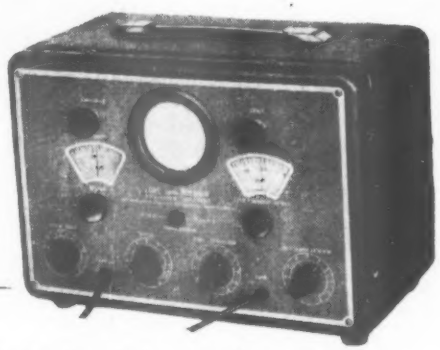
List Price £14.0.0 *Immediate Delivery*

Model 260A Television Wobbulator.

Model 260A provides entirely self-contained visual alignment facilities for Television receivers.

Carrier Frequency Range : 5 to 70 Mc/s.
Frequency Deviation : Adjustable from 0 to 5 Mc/s. total.
Sweep Frequency : 50 c.p.s. sinusoidal.
Output Voltage : Adjustable from 0 to 10 mV. approx.

List Price £36.15.0 *Immediate Delivery*



Available through your usual supplier. For full details of the complete range of Taylor instruments please write for our new 16 page catalogue.

★ **Illustrated instruments are available on Hire Purchase**

TAYLOR ELECTRICAL INSTRUMENTS LTD.

Montrose Avenue · Slough · Bucks. Telephone : Slough 21381

	VF	If	Ia (pk)	P.I.V. (max)
ESU 76	2.0V	7.5A	1.0A	10KV
ESU 200	4.0V	11.0A	5.0A	15KV
ESU 575	5.0V	11.0A	6.0A	15KV
ESU 866	2.5V	5.0A	1.0A	10KV
ESU 872	5.0V	7.5A	5.0A	10KV

MERCURY VAPOUR

rectifiers &

RADIATION COOLED

power triodes

ES 85

ES 85 VF-10V If-3-5A Va (max)-1.25KV Wa-85w μ-12.7 Ra-3,450Ω Maximum audio power output (per pair)-245 watts.

ES 833

ES833 VF-10V If-10A Va (max)-4KV Wa-400w μ-35 Maximum audio power output (per pair)-2KW Maximum R.F. power output (single valve)-1.45KW Maximum frequency at full rating-30Mcs. At reduced ratings the frequency may be uprated to 75 Mcs.

V 1505

V1505 VF-14V If-6.5A Va (max)-3KV Wa-275w μ-16 Ra-2,000Ω Maximum peak power output (per pair) on normal broadcast services-1KW.

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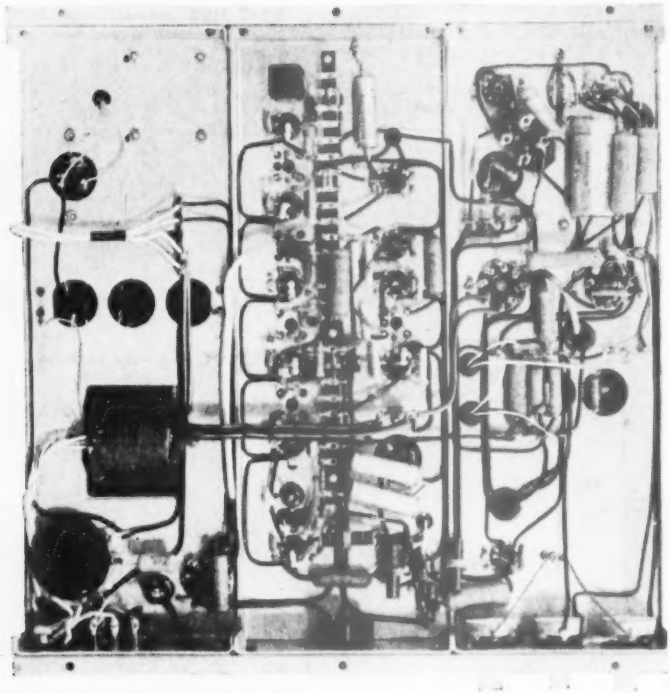
EV 92

For the Home Constructor



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12" 14" or 17"

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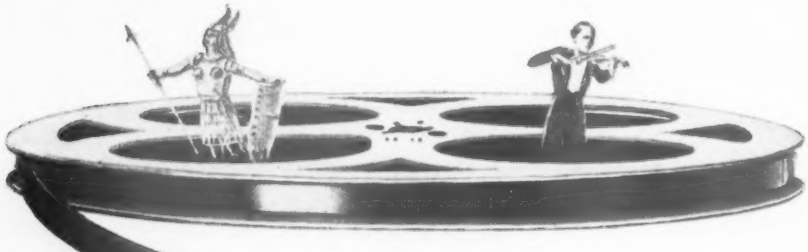

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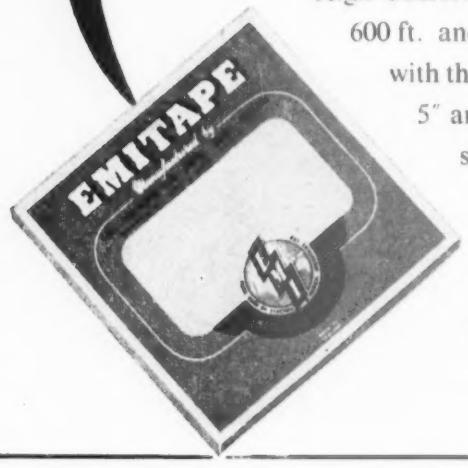

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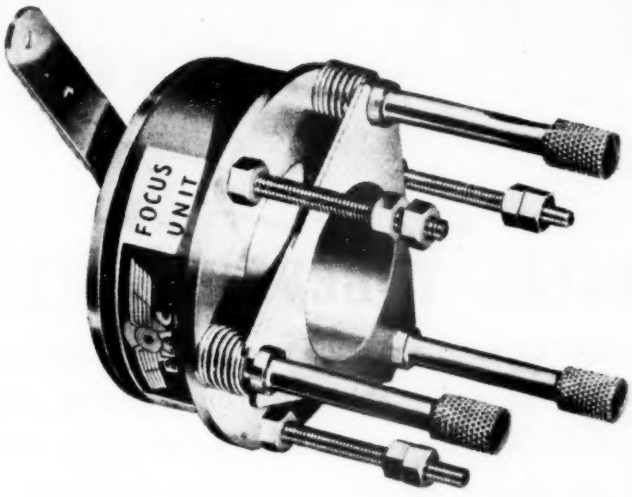

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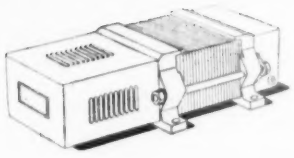

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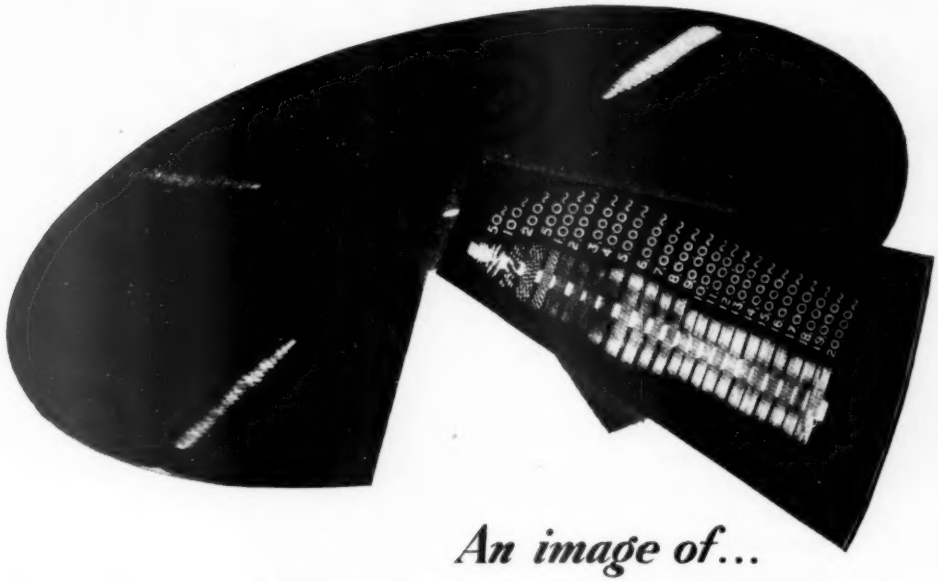

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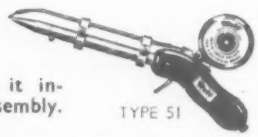

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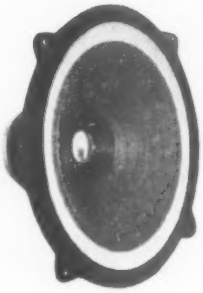

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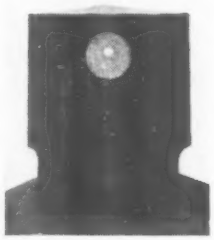

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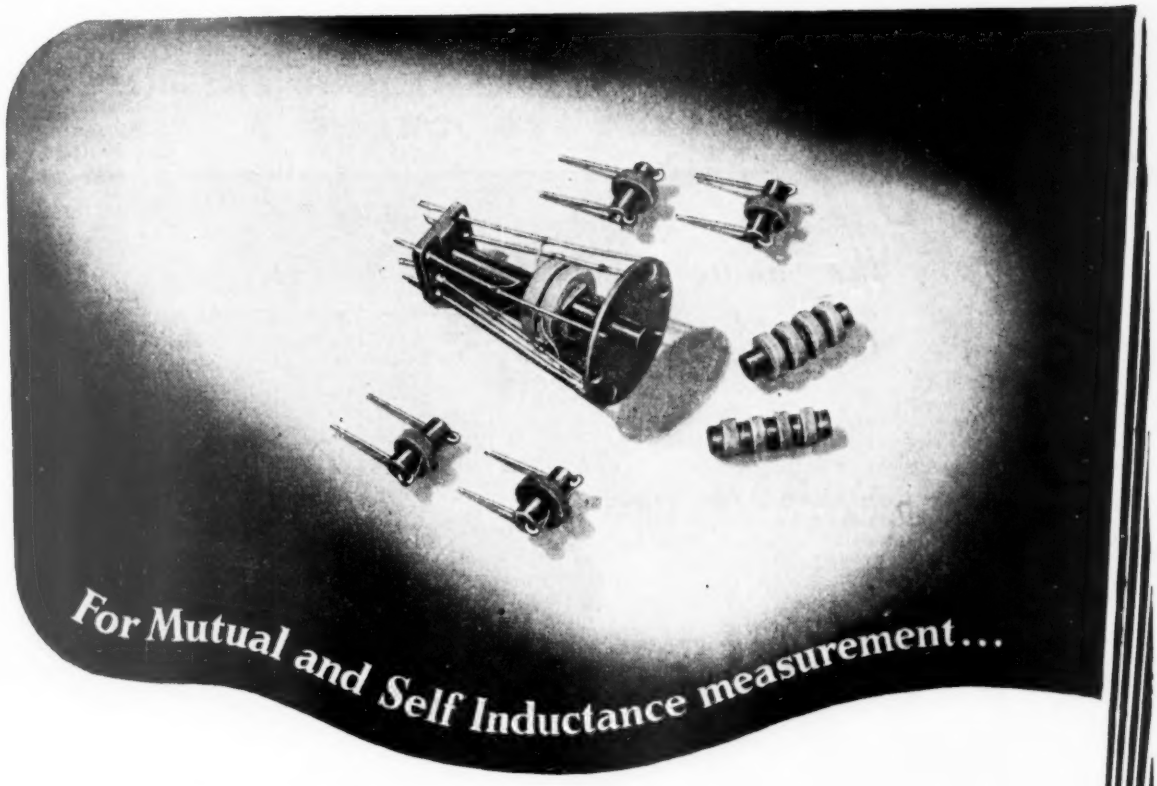

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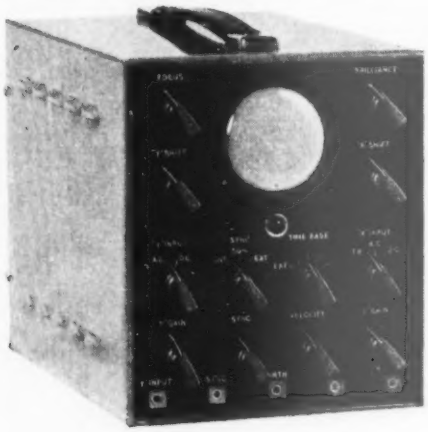

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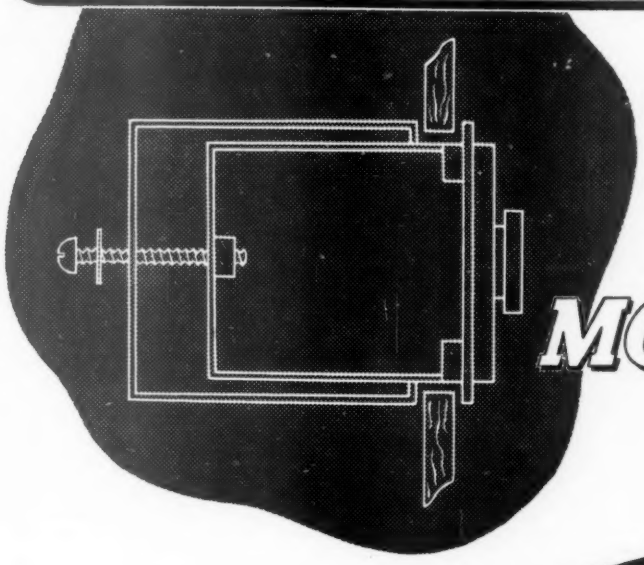
★ A POINT OF DETAIL NO. 4 ★



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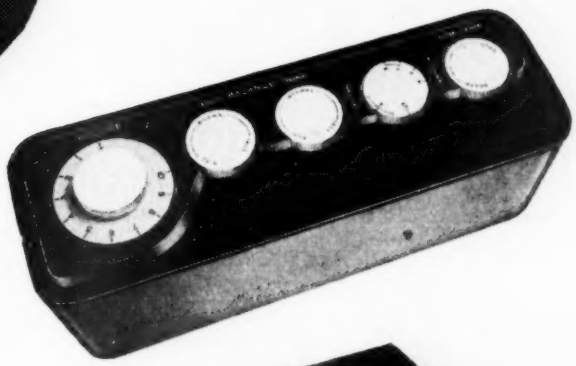

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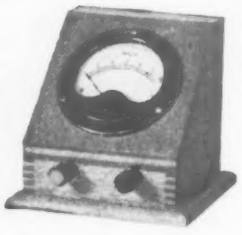

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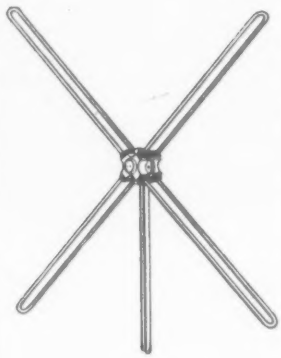

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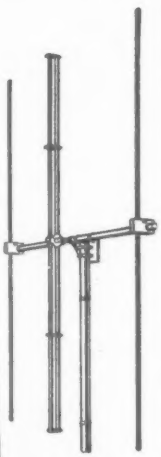

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● Manufactured by Aerialite Ltd., Castle Works, Stalybridge, Cheshire.

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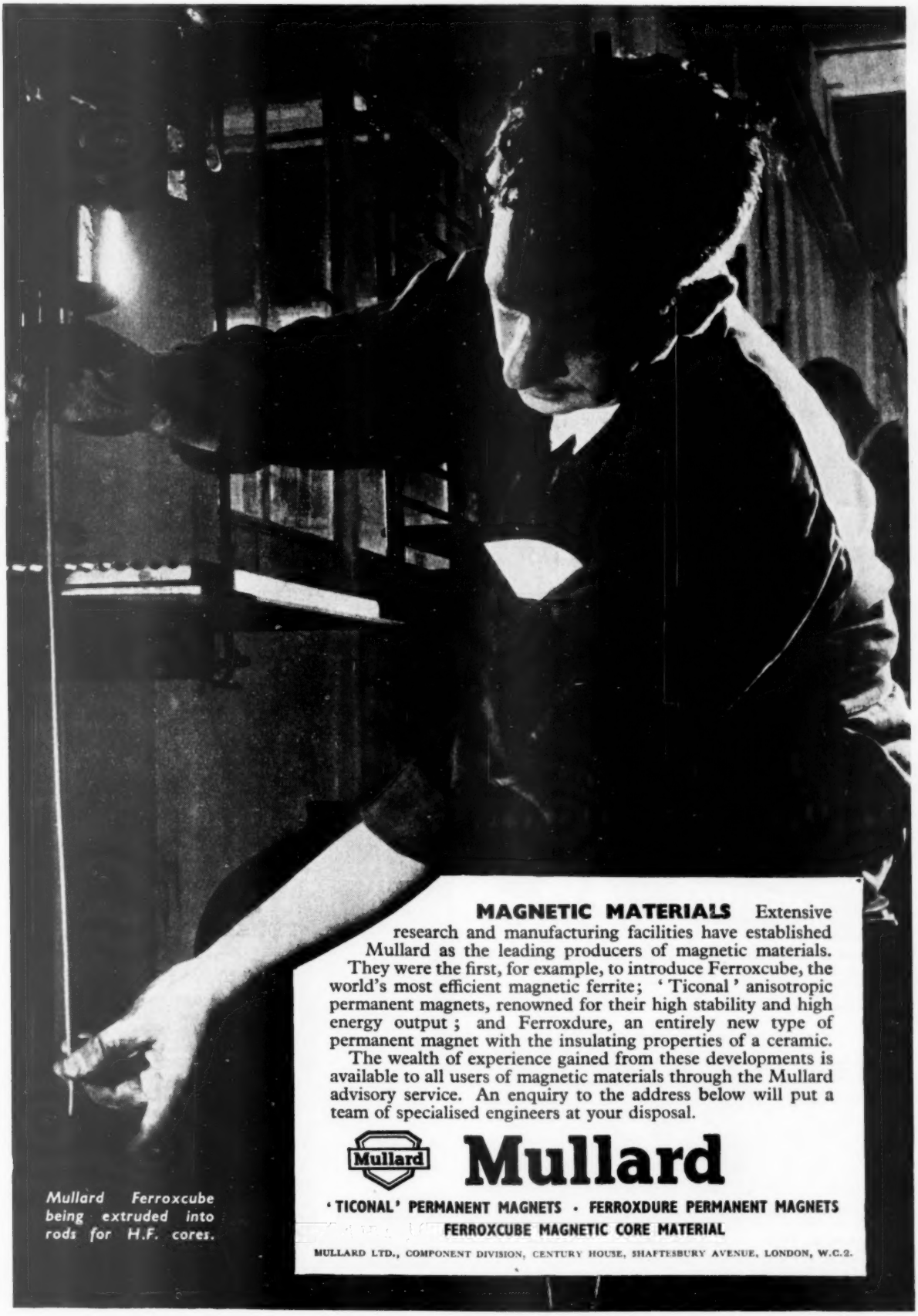

Mullard Ferroxcube being extruded into rods for H.F. cores.

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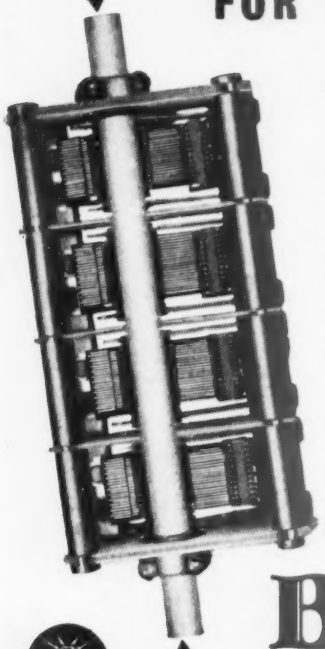

The illustration shows a Four Gang Radio Variable Condenser using our "FREQUELEX" Ceramic Rod for the Centre Rotating Spindle. This Rod is 7¼" long × .437" diameter, centreless ground to within plus or minus .0005". Maximum camber allowance of .002".
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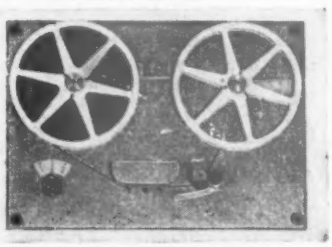

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Self inductance of primary winding at 300 c/s—1 volt drop	3.0 Henries	6.5 Henries
Corresponding flux density	13.5 Gauss	336 Gauss
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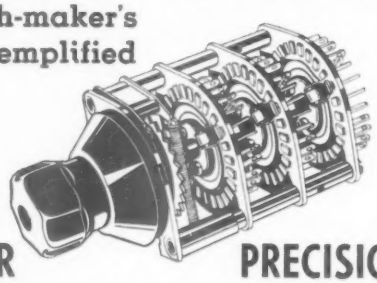

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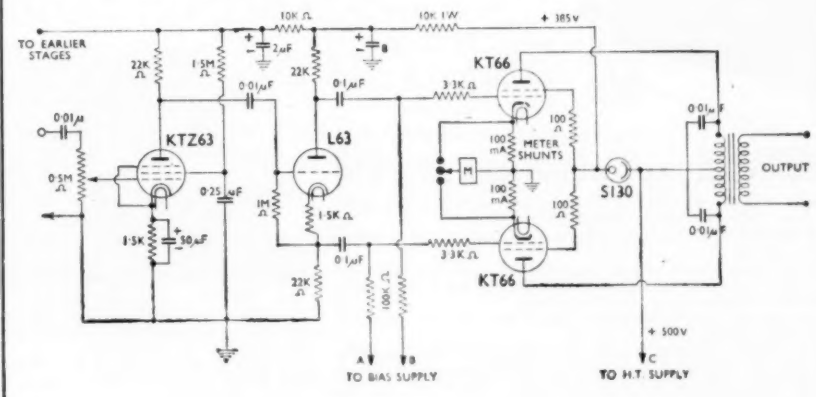
Typical circuit of 50W class ABI amplifier



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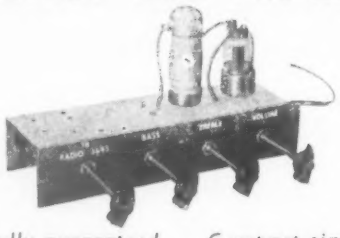

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Special features include—

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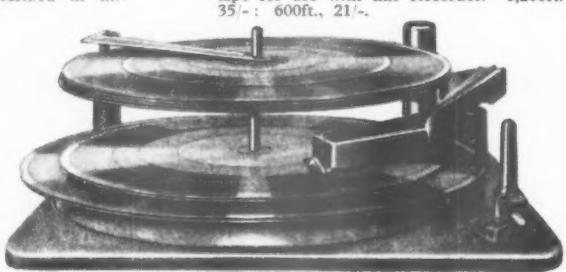

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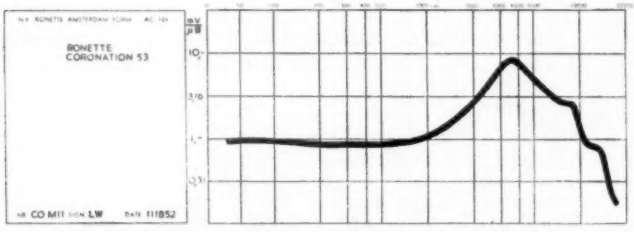

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★ Vibration and shockproof, not affected by low frequency wind noises.
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★ Recommended load resistance 5 MegΩ for flat response at low frequencies.
★ Annealed corrosion resistive aluminium diaphragm.

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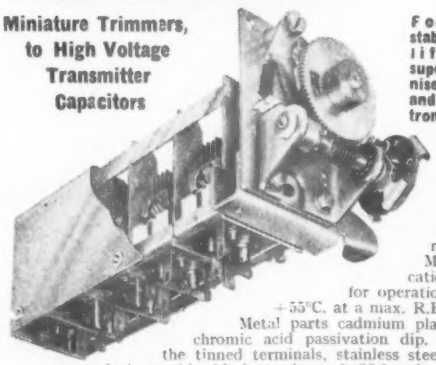

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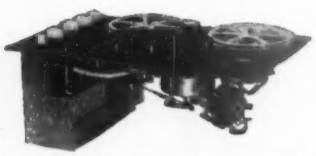

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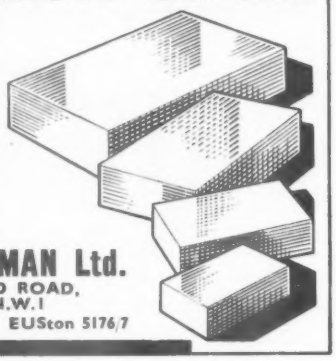

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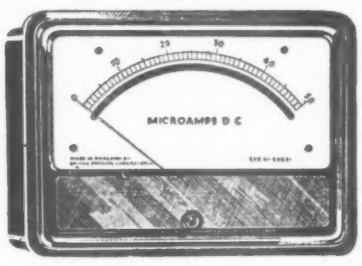

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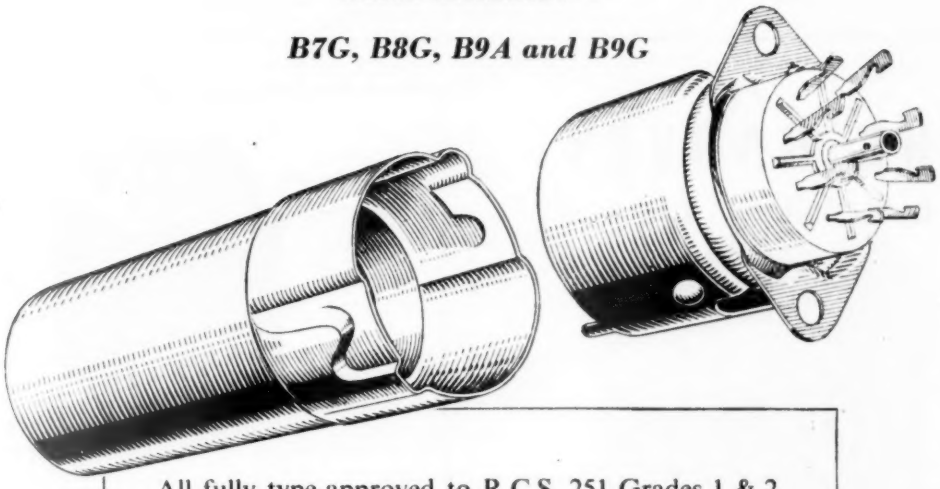

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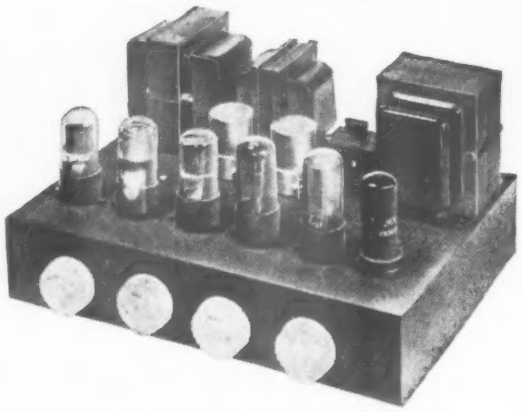

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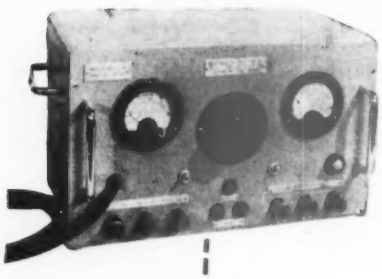

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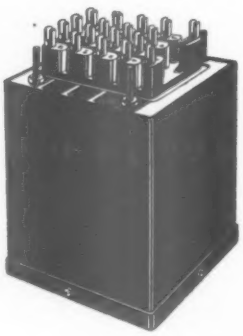

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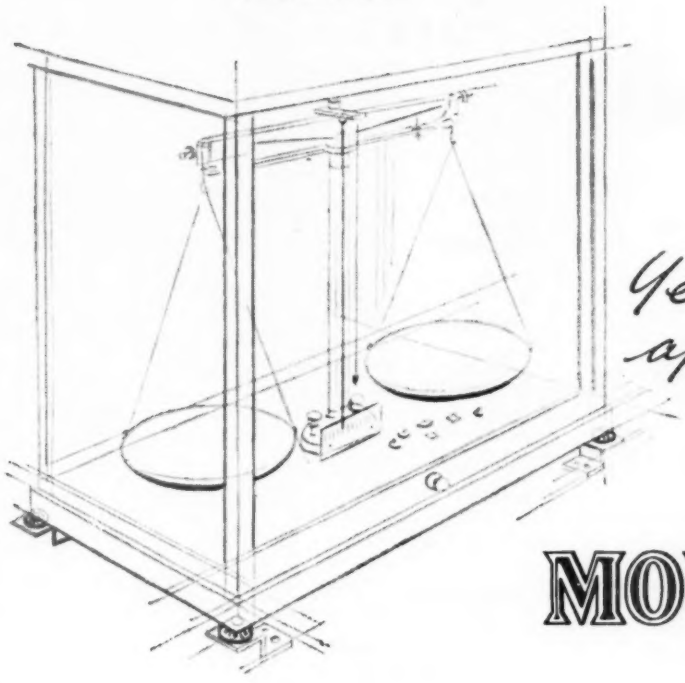

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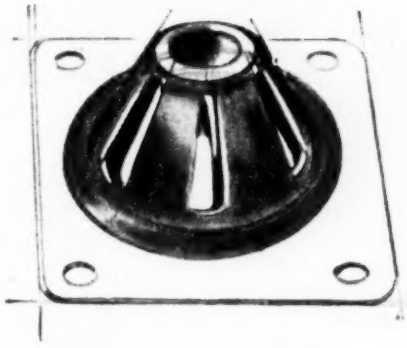

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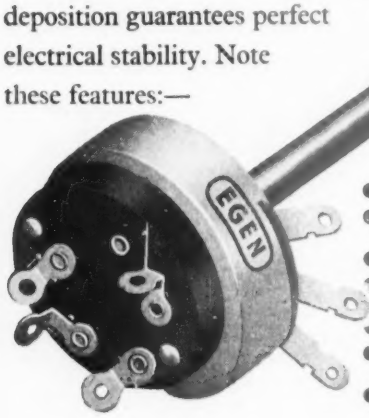

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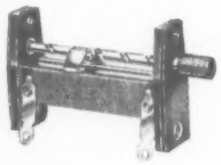

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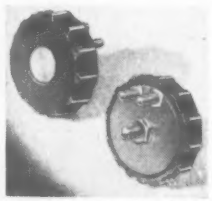

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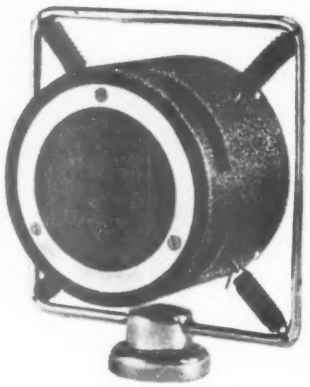

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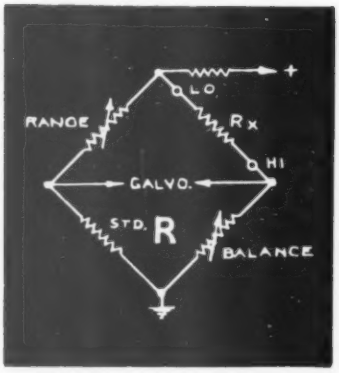

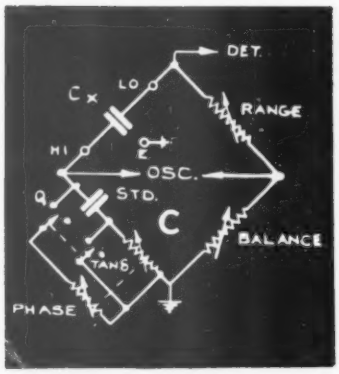

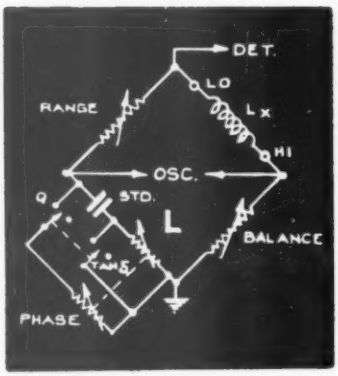

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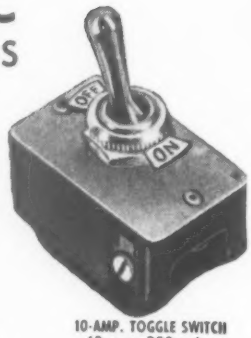

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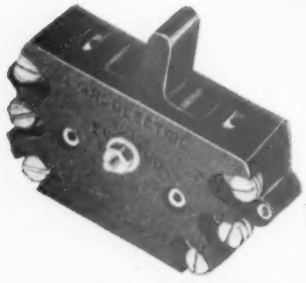
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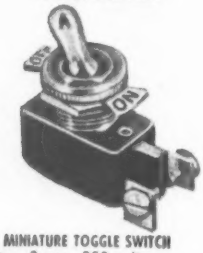

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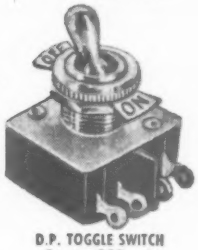

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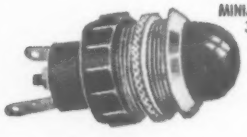
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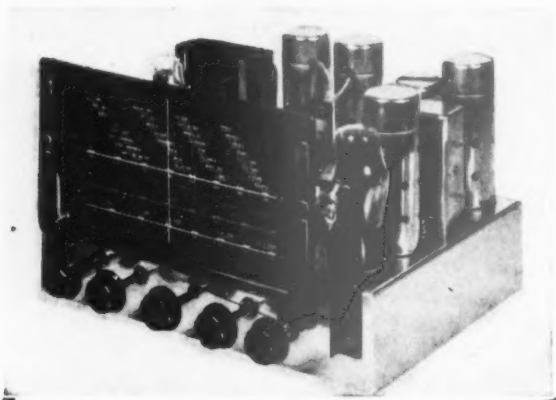

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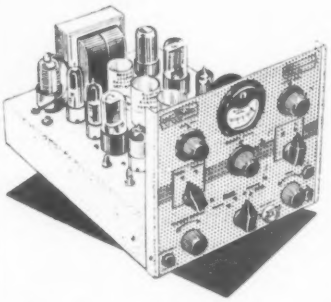

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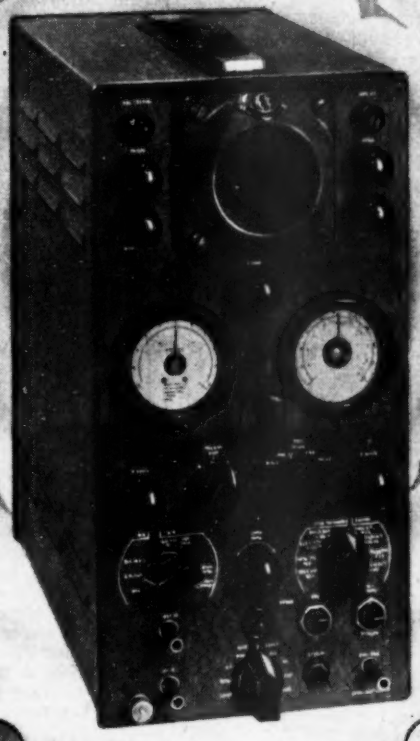

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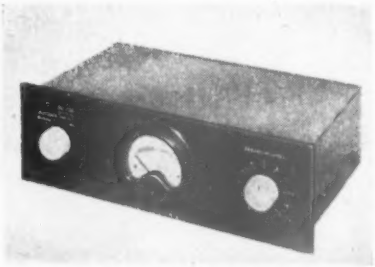

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U/TA TAPE PRE-AMPLIFIER

A compact High Fidelity unit designed to enable you to use a Tape Desk with your sound reproduction equipment. **PRICE £15 0 0.**

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Valves : 2 EF.40, 1 ECC.40, 1 EL.41 Oscillator.
Switch positions : 1. Playback ; 2. Record Microphone ; 3. Record Radio ; 4. Normal.
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Current systems : H.T. 300 v. 30 m/a. L.T. 6.3 v 1.7 amps.
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This High Fidelity equipment is demonstrated with the Wearite Tape Deck at our Showrooms.

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It gives an output of 4.5 watts at .2% distortion (less than .1% at 3 watts).
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Simple and instantly effective push button controls give you complete mastery over the "Reporter's" magnificent recording and reproducing qualities. Twin track tapes give a full hour's recording and play-back time—and play-back can be effected immediately. For amateur broadcasts, professional operators and home entertainment, the "Reporter" revolutionises the fascinating business of recording and reproducing sound.

MASTERLY DESIGN
OUTSTANDING PERFORMANCE
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ABRIDGED SPECIFICATION

Silent fast forward and reverse rewind—2 mins. Tape length—1,200 feet at 7½ in. per second. Consumption 60 watts approx. Frequency range—50 c.p.s.—10,000 c.p.s. d.b. Loudspeaker—elliptical permanent magnet coil. Mains voltage—A.C. only 110, 125, 220, 240. Price with high fidelity microphone **75 gns.** *H.P. Terms available.*

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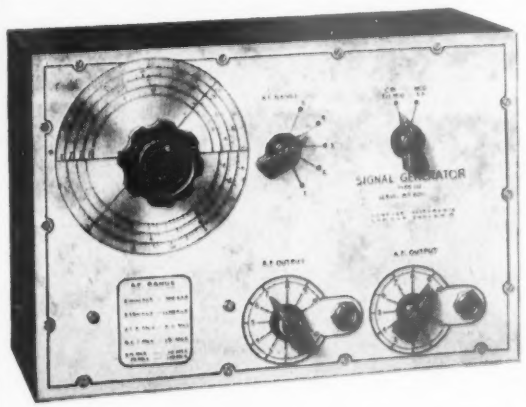

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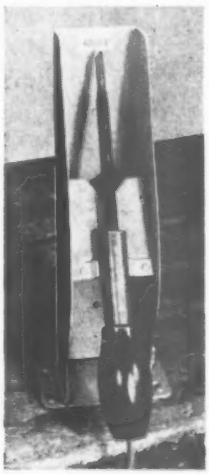

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For
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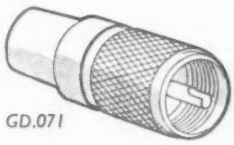
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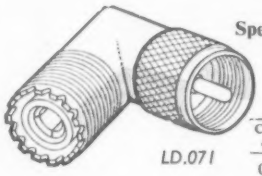
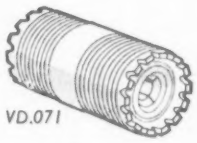
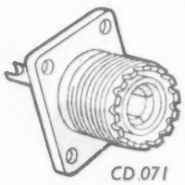
for cables of 0.2″ to 1.03″ O.D.
Single and multi-way types.
Special types fitted with coupling rings.
Cable joining connectors.
U.S. Type Connectors as illustrated.


LD.071


VD.071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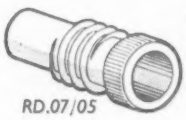
RD.07/05

CABLE O.D.	TYPE	CODE NO.
0.41″	Straight plug	GD.071
0.25″	Reducing adaptor	RD.07/05
0.2″	Reducing adaptor	RD.07/03
fits on GD.071 CD.071 VD.071	Elbow plug adaptor	LD.071
fits on GD.071 LD.071	Bulkhead (Junction) adaptor	VD.071
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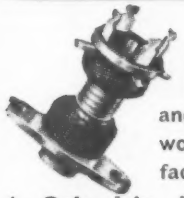

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★ Variable iron-dust cores. ★ Fitted tags for easy connection.
★ Low loss Polystyrene formers.

COILPACKS. A full range is available for Superhet and T.R.F. Mains or Battery. Size only 1⅞in. high x 3¼in. wide x 2¼in. Ideal for the reliable construction of new sets, also for conversion of the 21 RECEIVER, TR 1196, TYPE 18, WARTIME UTILITY and others.

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Frequency coverage 150 kc/s. to 20 m/c.
Iron-dust core and single-screw fixing
Prototype tested and approved by M. G. Scroggie, B.Sc., M.I.E.E.
Ideal as anode load in TRF receivers, for decoupling and general purposes. Price 4/-.

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Supplied complete with *both* No. 2 and No. 3 punches and dies for **30/-** (postage and packing 1/3 or **16/-** *one* punch and die only. (Please state which.)

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Complete with punch and die.....**5/9** post free.

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You won't believe it!

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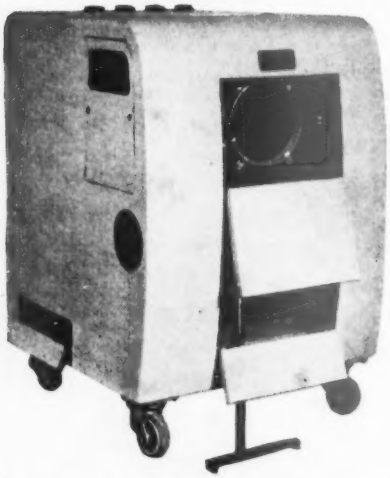
"TELEMAX" TELEVISION PROJECTOR



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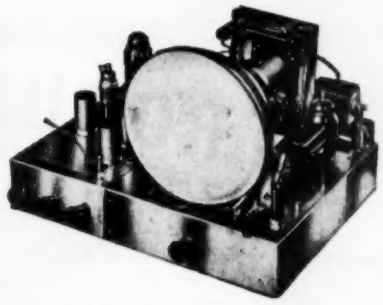

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Ediswan Morganite Resistors :	
No. 40A London	1 16 3
No. 40B/E Midland/Wenvoe } No. 40C/D H. Moss/Kirk o' Shotts }	1 15 3
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- Spring-loaded gears with automatic take-up of any wear or play between primary and secondary drives.
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53	2,000	6.6 feet	1 : 15	1 : 200

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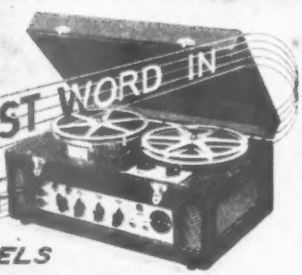

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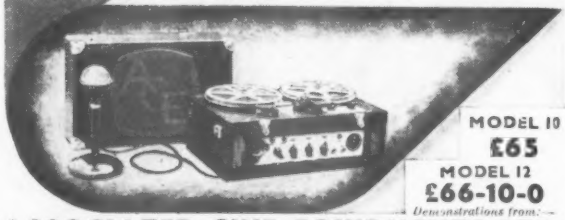

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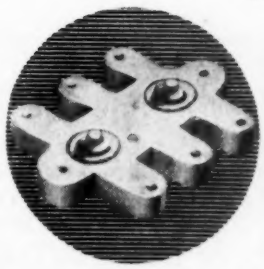

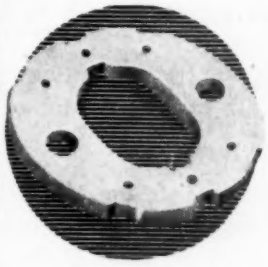

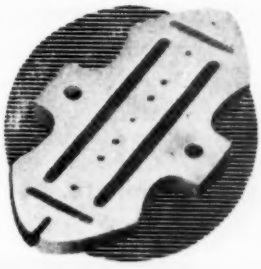

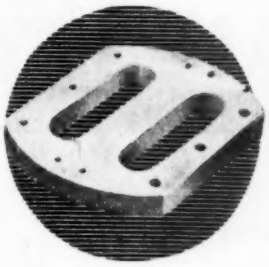

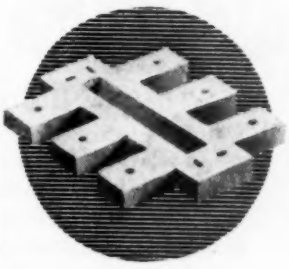

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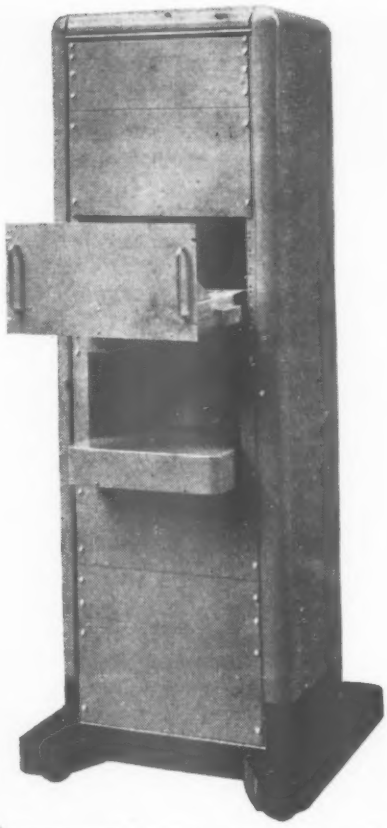

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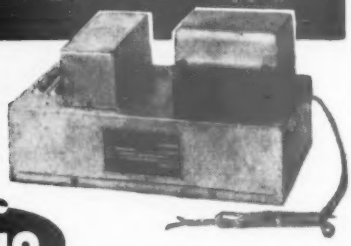

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3.	Leak Vari-Slope	£12 12 0	£4 4 0	17/6
4.	Quad Amplifier	£35 0 0	£12 0 0	44/2
5.	Quad Radio Feeder Unit	£26 10 0	£9 0 0	33/4
6.	Sound Sales AZ Amplifier	£32 10 0	£12 10 0	33/4
7.	Rogers R.D. Minor	£11 0 0	£4 0 0	15/-
8.	Rogers Baby de luxe Amplifier	£21 0 0	£7 0 0	26/6
9.	Decca Type N.F.A.5	£17 10 0	£6 10 0	21/8
10.	Decca Type No. P.A.6	£26 5 0	£8 5 0	35/-
11.	Goodsell Amplifier 8A.10	£15 15 0	£4 0 0	23/4
12.	Goodsell Control Unit U/TC	£8 8 0	£3 0 0	12/6
13.	Goodsell Control Unit F/U/IC	£12 12 0	£4 4 0	17/6
14.	Goodsell MA15 Amplifier	£19 10 0	£6 10 0	33/8
15.	Goodsell Williamson	£33 5 0	£12 10 0	38/4
16.	Goodsell Control Unit P/FA	£22 10 0	£7 10 0	28/9
17.	Lowther LES	£25 15 4	£9 0 0	32/2
18.	Lowther AP.10	£35 0 0	£12 0 0	44/1
19.	Lowther DT.5	£36 17 10	£12 12 0	46/6
20.	Lowther VHF Unit	£9 7 8	£3 7 8	11/6

TAPE DESKS AND TAPE RECORDERS

Item No.	Description	Cash	or Deposit	and 12 p'ments
61.	Truvox Tape Deck	£23 2 0	£8 0 0	30/2
62.	Bradmatic Tape Desk	£42 0 0	£14 0 0	55/-
63.	Wearite Tape Deck Type A	£35 0 0	£12 0 0	45/-
64.	Wearite Tape Deck Type B	£40 0 0	£13 6 8	50/-
65.	Lane Tape Deck	£16 10 0	£5 10 0	22/-
66.	Qualtape	£16 16 0	£5 17 6	22/-
67.	Electrotech Pro. Desk	£75 0 0	£25 0 0	97/1
68.	M.S.S. Type PRM/1	£150 0 0	£50 0 0	191/8
69.	Ferrograph Type A	£79 10 0	£26 10 0	100/-
70.	C.J.E. Portable	£119 0 0	£40 0 0	146/8
71.	Vortexion	£85 0 0	£30 0 0	105/6
72.	Grundig Model A	£78 15 0	£28 15 0	95/10
73.	Grundig Console	£99 15 0	£33 5 0	127/6
74.	Simon Model A	£83 0 0	£28 0 0	124/7
75.	Soundmirror Portable	£79 10 0	£26 10 0	100/-
76.	Soundmirror Table Model	£69 10 0	£23 10 0	88/2
77.	Reflectograph Tape Recorder	£95 0 0	£33 0 0	118/10
78.	E.M.I. Emicorda	£90 0 0	£30 0 0	115/-
79.	Wirek Reporter	£59 0 0	£20 0 0	74/-
80.	E.M.I. Reporter	£130 0 0	£45 0 0	163/-

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22.	Garrard RC.80	£19 19 0	£6 10 0	25/9
23.	Garrard Trans. Motors 201/B5	£24 12 6	£8 12 6	30/8
24.	Connoisseur 2-speed Motors	£17 10 0	£6 0 0	22/-
25.	Connoisseur 3-speed Motors	£23 12 0	£7 12 0	30/8
26.	Decca GU.4	£9 19 11	£3 10 0	14/-
27.	Decca GU.4A	£11 17 6	£4 0 0	16/8
28.	Decca GU.4M	£13 10 0	£5 0 0	18/6
29.	Collaro RC.511	£12 5 0	£4 5 0	15/4
30.	Collaro RC.500	£10 15 0	£4 0 0	13/-
31.	Collaro RC.522	£15 15 6	£5 5 0	20/1
32.	B.S.R. Monarch Auto	£17 17 0	£6 6 0	22/2
33.	B.S.R. Monarch in case	£18 12 6	£6 6 0	23/7
34.	Plessey 3-speed Autochanger	£17 10 0	£6 0 0	22/-
35.	Chancery L.P. Attachment	£3 15 0	—	—
36.	B.S.R. MU.10	£3 18 7	—	—
37.	B.S.R. MU.14	£6 8 6	£2 0 0	8/6
38.	B.S.R. GU.4	£13 19 0	£5 0 0	17/2
39.	Garrard RC.72A (8-hand)	£12 10 0	£4 10 0	15/4
40.	Garrard RC.65A (8-hand)	£10 10 0	£4 0 0	12/6

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Item No.	Description	Cash	or Deposit	and 12 p'ments
81.	Decca XMS with 2 heads	£7 0 0	£3 0 0	7/8
82.	Decca Hi-Fi Magnetic Head	£2 19 4	—	—
83.	Connoisseur Pick-up	£6 9 0	£2 10 0	7/7
84.	Connoisseur Extra Heads	£3 11 5	—	—
85.	Connoisseur P/U Transformer	15 0	—	—
86.	Leak Ruby Std.	£12 12 0	£4 4 0	16/2
87.	Leak Ruby LP	£12 12 0	£4 4 0	16/2
88.	Leak Diamond Std.	£19 2 6	£6 10 0	24/2
89.	Leak Diamond LP	£19 2 6	£6 10 0	24/2
90.	Leak Pick-up transformer	£2 15 0	—	—
91.	Acos G.P.19	£3 11 5	—	—
92.	Acos G.P.20	£3 11 5	—	—
93.	Acos G.P.30	£3 11 5	—	—
94.	Acos L.P. and Std. Heads	£2 3 4	—	—
95.	Acos Pick-up Arm	£1 7 6	—	—
96.	Decca Pick-up Arm	£1 7 6	—	—
97.	Lowther Hi-Fi Moving Coil	£10 8 0	£3 10 0	13/3
98.	Decca T/O Crystal	£2 5 0	—	—
99.	Wharfedale X-Over Units from	£2 5 0	—	—
100.	E.M.G. Steep-cut Filter	£4 10 0	—	—

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42.	Goodmans 101 8in.	£7 2 9	£2 0 0	11/8
43.	Goodmans 102 8in.	£10 14 2	£3 14 2	15/-
44.	Goodmans 150 Mark II	£14 9 0	£4 9 0	20/-
45.	Tannoy Duo-Concentric 12in.	£27 10 0	£9 10 0	30/8
46.	Tannoy Duo-Concentric 15in.	£33 10 0	£11 10 0	42/2
47.	Decca Corner Speaker	£31 0 0	£10 6 8	39/8
48.	Wharfedale Corner Baffle 10in. C.S.B.	£24 10 0	£8 10 0	30/8
49.	Wharfedale 10in. Golden Unit	£8 6 0	£3 0 0	10/2
50.	Wharfedale 10in. C.S.B.	£9 0 0	£3 0 0	11/6
51.	Rogers Column	£30 0 0	£10 0 0	38/4
52.	Wharfedale Super 12/CS/AL	£23 1 10	£8 0 0	30/11
53.	Wharfedale W.15/CS	£16 0 0	£5 6 8	20/6
54.	Wharfedale 3 unit	£87 10 0	£30 0 0	110/2
55.	Voigt	£87 0 0	£30 0 0	109/3
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57.	Acoustical Corner Ribbon	£95 0 0	£35 0 0	115/-
58.	Lowther Domestic Horn	£60 0 0	£20 0 0	76/8
59.	W.B Stentorian Tweeter Unit	£3 15 6	—	—
60.	Vitavox Klipshorn	£150 0 0	£50 0 0	190/-

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102.	Bradmatic Oscillator Coil	9 0
103.	Bradmatic Bias Rejector Unit	12 6
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105.	Bradmatic Tape Guides	5 0
106.	Bradmatic 5RP Heads	£3 5 0
107.	Bradmatic 6RP Heads	£3 15 0
108.	G.E.C. Tape, per reel	£1 10 0
109.	Scotch Boy Tape	£1 15 0
110.	Collaro Tape/Rec. Motors	£1 18 0
111.	Acos Microphone	£6 6 0
112.	Rothermel Mike	£3 0 0
113.	Reslo Ribbon Mike	£9 9 0
114.	Reslo Table Stand	£2 12 0
115.	Reslo Moving Coil Mike	£5 5 0
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117.	B.S.R. SR.12,750 r.p.m.	£1 12 0
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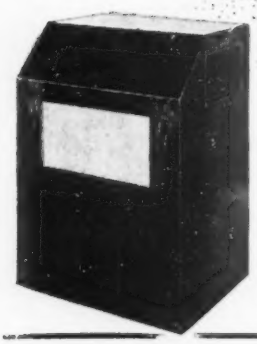

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„ 74	„ 615	„ 877	„ 1069	„ 1287	„ 1943
„ 118	„ 616	„ 885	„ 1073	„ 1296	„ 1945
„ 124	„ 619	„ 887	„ 1075	„ 1300	„ 1948
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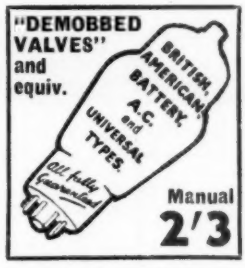
„ 575	„ 786			„ 1864	„ 2938
„ 583	„ 815			„ 1891	„ 2941
„ 585	„ 822			„ 1893	„ 2985
„ 588	„ 845			„ 1896	„ 2996
„ 594	„ 848			„ 1900	„ 2999
„ 596	„ 851			„ 1926	„ 3502
„ 606				„ 1931	„ 3527

"DEMOBBED VALVES" and equiv.


Manual **2/3**

CONDENSERS
Wire Ends

2 m/d 450 v.	2/-
4 „ 450 v.	2/6
8 „ 500 v.	2/6
16 „ 500 v.	2/9
25 „ 25 v.	1/3
50 „ 50 v.	2/-

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8×8 m/d. 500 v.	3/6
8×16 „ 500 v.	4/9
16×16 „ 500 v.	5/9
16×24 „ 350 v.	5/9
16×32 „ 275 v.	6/6

16 m/d. Govt. Surplus 175 v. each **1/-**. Post 6d.

MORSE BUZZER OUTFITS
Consisting of a buzzer, a morse key and a battery compartment, all mounted on a polished baseboard. All parts high grade ex-Air Ministry. An excellent gift for a boy. Post free.
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All Purpose INSPECTION AND GARAGE HAND LAMP
With stout galvanised wire guard. Superior quality. (Less flex and bulb.)
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Ex-Govt. Surplus SPEAKER
Matching Transformers Guaranteed Sale Price
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SERVICE SHEETS
The one you require enclosed if available in a dozen assorted of our best choice.
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ROD Antennas
1ft. Sections, interlocking and extending, copper plated steel. BARGAIN, dozen
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B.T.H. Germanium Crystal Diode
for the "HANDY-MAN," Crystal Valves Radio Receiver, complete with Diagram and operating instructions.
3/-

ADCOLA 3/16in. DIA. BIT SOLDERING INSTRUMENT.
Miniature type to meet every requirement for Radio, Television, etc.
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● The Perfect Small Soldering Iron. ● Adjustable Bit. ● Easy to Handle. ● Weight approx. 4 oz. ● Heating Time 3 min. ● 40 watt Economy Consumption. ● Voltage Ranges 100/110 v., 200/220 v., 230/250 v., other ratings available on request. ● Long Life and Efficiency. ● Replacement Elements and Bits always available. Just the convenient Iron required for intricate and fine soldering.
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SAFE . . . puts the heat just whereit's wanted —nowhere else.
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6 TOOLS IN ONE
10/- Plus 1/6 post and pkg. (reduced from 20/-)
Punches, Bends and Shears Metal Strip, Rod and Angle. Every Handyman, Mechanic and Service Engineer needs one! 1,000 used!

Unique! Order TODAY!

High-power super-heat flame. PERFECT for Light Brazing, Tempering, Hard Soldering, Silver Soldg., Tinning, Sweating, etc. Fits into ordinary Gas Tubing. No extra air pressure. Full instructions.
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Manufacturers of Ammeters, Voltmeters, Ohmmeters, Watt-meters and frequency meters for switchboard or portable use.

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The Universal testing set for Service Engineers. Sensitivity 10,000 ohms per volt. Strong metal case with carrying handle, complete with leads having detachable bulldog clips and test prods. Size 9 x 5½ x 4 ins.

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AC/DC VOLTS: 10, 25, 100, 250, 500. 1,000.
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AC/DC MICROAMPS: 100 Microamps 10v range.
RESISTANCE RANGES: 0/1 Meg (13,500 ohms mid-scale) 0/10,000 ohms (135 ohms mid-scale).

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WORKING MODELS OF THE PREMIER TAPE RECORDERS CAN BE SEEN AT THIS ADDRESS.

Now being delivered... The PREMIER De Luxe PORTABL MAGNETIC TAPE RECORDING KIT

THE 7 VALVE AMPLIFIER HAS BEEN SPECIALLY DESIGNED FOR HIGH QUALITY REPRODUCTION

Brief Specification:

VALVE LINE-UP :—EF37A First Stage 6SL7 Second Stage and Tone Control: 6V6 Output; 6X5 Rectifier; VT501 Bias and Erase Oscillator; 7193 Record Level Amplifier; 6U5 Magic Eye Record Level Indicator.

OUTPUT :—4 Watts **FREQUENCY RANGE** :—50 c.p.s. to 9,000 c.p.s.

CONTROLS :—Volume; Record/Playback Switch; Treble Boost; Bass Boost—on/off.

A VISUAL MAGIC EYE Record Level Indicator is incorporated.

The unit is housed in a superbly finished rexine covered portable cabinet which incorporates a compartment for the Microphone when not in use. Weight complete 35 lb. Dimensions :—21in. long; 12½in. deep; 9½in. high.

This Recording Outfit has been designed for use with M.C.-1-111 "SCOTCH BOY" Magnetic Tape. With this high quality tape a frequency range of 50 c.p.s. to 9,000 c.p.s. at tape speed of 7½in./sec. can be readily achieved. Additional reels of 1,200ft. can be supplied at 35/-.

★ *Including ALL parts, Valves, Portable Cabinet, 8in. Loudspeaker, Tape-Table, Reel of 'Scotch Boy' Tape and Rewind Spool, and Microphone.*

★ £37·4·0

(Plus 15/- Pkg. Carr. Ins.)

The Recorder incorporates the NEW LANE TAPE TABLE

Brief Specification:—

Made to high standards and incorporating features ensuring low level of "Wow" and "Flutter" throughout the full length of tape.

FAST REWIND. Provision for fast rewind and forward run in less than 1 min. in either direction. THREE MOTORS obviating friction drive.

HIGH FIDELITY RECORD PLAYBACK (1 HOUR APPROX. PLAYING). The Table is fitted with high fidelity record playback head of new design wound to high impedance and a separate A.C. Erase Head. The Heads are half-track size allowing approx. 1 hr. playing from standard 1,200ft. Reel of Tape.

TAPE SPEED 7½in. sec.
For use on A.C. 200/250, 50 cycles mains only.

MICROPHONE—Crystal—Specially designed for Premier by famous manufacturer.

To those unable to build this PORTABLE TAPE RECORDER we can supply it completely wired, tested and ready to plug in at **39GNS.**

Plus 1 gn. pkg./carr.

SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW—

AMPLIFIER KIT (including 8in. Speaker) ...	**£11. 0.0** plus 5/- pkg./carr.
AMPLIFIER (already built, wired and tested)...	**£14.15.0** plus 7/6 pkg./carr.
LANE TAPE TABLE and REWIND SPOOL	**£16.10.0** plus 7/6 pkg./carr.
PORTABLE CABINET (rexine covered).....	**£4.19.6** plus 5/- pkg./carr.
MICROPHONE.....	**£2 19.6** plus 1/- pkg./carr.
REEL OF "SCOTCH BOY" TAPE (1,200ft.)	**£1.15.0** plus 6d. pkg./carr

As is usual in all PREMIER KITS every single item down to the last nut and bolt is supplied. The Chassis is punched and layout diagrams and theoretical circuits are included.

INSTRUCTIONAL BOOKLET . . . 2/6

This is credited if a complete kit of the Tape Recorder is ordered.

When completed the PREMIER PORTABLE TAPE RECORDER compares MORE than favourably with any other make at double the price.

PREMIER

TABLE MODEL MAGNETIC TAPE RECORDER

INSTRUCTIONAL BOOKLET . . . 2/6

This is credited if a complete Kit of the Tape Recorder is ordered.

IN KIT FORM—The Kit includes ALL parts, valves, cabinet, loudspeaker, Reel of "Scotch Boy" Tape, Rewind Spool and The NEW Lane Tape Table already assembled (*but excluding Microphone*).

SPECIFICATION AS PREVIOUSLY ADVERTISED

£29 : 8 : 0

(Packing and Carriage 15/-)

COMPLETE—to those unable to build this TAPE RECORDER, we offer it built, tested and ready to plug in, complete with "RONETTE" Microphone. Reel of "Scotch Boy" Tape and Rewind Spool.

SPECIFICATION AS PREVIOUSLY ADVERTISED

£36 : 10 : 0

(Packing, Carr & Ins. 1 Gn.)

★ *All the above Recorders are Fully Covered by the usual Premier Guarantee—3 months valves—12 months other components.*

The NEW Microphone . . . for TAPE RECORDING • AMATEUR RADIO • PUBLIC ADDRESS

A CRYSTAL MICROPHONE made specially for Premier by one of the world's leading manufacturers of Microphones. Although giving better all-round performance than most Microphones, we are able to offer this Unit at less than half the price of any comparable Microphone of other makes.

Brief Specification:—

SENSITIVITY—minus: 55 d.b. relative to 1 v./-dyne/-cm².

RESPONSE—essentially flat from 30-10,000 c.p.s., recommended load resistance 5 megohms for flat response at low frequencies (2 megohms for slightly reduced bass response).

DIMENSIONS—overall length 5¼in. Width 2¾in. at widest part of Ball Top, tapering to ¾in. at base of housing.

PRICE

£2 : 19 : 6

The Microphone is unaffected by mechanical vibrations and low frequency wind noises. An attractive black all-metal housing provides complete screening and protection for the crystal insert. The crystal is virtually unbreakable and specially treated to minimise the effect of humidity. The modern design of the Unit enables it to be used as a Hand Microphone, with a Base as a Desk Microphone, or fixed to a Pedestal Floor Stand. Screw fitting for any standard British type Stand.

Especially recommended for use with the PREMIER MAGNETIC TAPE RECORDER

ALSO AVAILABLE FROM STOCK: **LUSTRAPHONE** *Moving Coil: High Impedance* Stand type: **75/12/6.** — Hand Mike: **56/6/-.** | **RONETTE** *Crystal Microphone: Incorporating the Filter Cell Insert. High Impedance* Ball type: **23/19/6.**

Table Stands for all the above **17/6.**

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Terms of Business: Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-. 1/6 under 40/- unless otherwise stated.

CAR BATTERIES—*BRAND NEW*

6 v. 11 plate—PREMIER. Height, 6¼in.; Length, 7¼in.; Depth, 6¼in. Price **65/-**.
6 v. 11 plate—PREMIER. Height 8¼in.; Length 6¼in.; Depth 6¼in. Price **65/-**.
12 v. 9 plate—PREMIER. Height, 8¼in.; Length, 12in.; Depth, 6¼in. Price **110/-**.
6 v. 15 plate—THOR. Height, 7¼in.; Length, 9in.; Depth 7in. Price **75/-**.
6 v. 40 amp—PREMIER. Parking Light Battery. Price **37/6**.
6 v. 16 amp—PREMIER. Parking Light Battery. Price **27/6**.

All prices plus 7/6 carr. and packing.

BATTERY CHARGERS

200-250 v. A.C. Will charge 6 v. or 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green hammered enamel. Size: 6in. long, 3¼in. wide, 3¼in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain ex-Govt. components. Plus 2/6 Post and Pkg.

39/6

BATTERY CHARGER KITS

All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. cycle mains.
Cat. No.
2002 Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator ..... **£1 . 2 . 6**
2003 Charges 12 volt accumulator at 1 amp. **£1 . 7 . 6**

CHARGER TRANSFORMERS

Input 230 v. A.C. Output 12 v. @ 1 amp. Completely shrouded. Price **9/11**.

Govt. *Surplus*—Ex W.D. STEEL AERIALS *ALL BRAND NEW*

12ft.—3 4ft. sections of copper-plated steel highly flexible tapering ⅜in. to ⅛in. Brand new in container, **6/9**. Packing and carriage **1/6**. Insulated Base, **3/-**. Webbing waterproof carrying case with shoulder sling, **2/6**.
These aerials make ideal fishing rods.

EX-U.S.A. U.H.F. AERIAL

with untuned detector stage, consisting of V.R.92 valve etc. Brand new, in carton, **5/-**.

2 STAGE QUALITY AMPLIFIER

Complete with 10 in. Energised LOUDSPEAKER

4 watts output. A.C. 110/230 mains.

£6.19.6

plus 5/- carriage.

FRACTIONAL H.P. MOTOR

A 50 v. 3-phase A.C. motor, 1/40th h.h.p. by famous maker. Supplied complete with resistor, condenser and circuit diagram to convert the motor to 1 h.p. for use on 240 v. single phase A.C. mains. Brand new, **25/-**, plus 2/6 carriage and packing.

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Luminous Dial, enclosed in black bakelite case. Size: 3in. × 2¼in. × 7¼in.

Price **18/6**.

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Balanced Armature Low Resistance
Type 1, **6/11** pair; Type 2, **8/11** pair.
High Resistance 12/6 pair
Lightweight High Resistance 14/6 pair.

METAL RECTIFIERS FULL WAVE

6 v. 1 amp., **4/-**; 12 v. 1 amp., **8/-**.
E.H.T. Pencil Type:
Output: 650 v. 1 mA., **4/7** each; 1,000 v. 1 mA., **6/-** each.

6L INDICATOR UNITS

Complete with VCR97, 4—VR91, 3—VR54. **£3.15.** Plus Pkg. and Carr. 7/6.

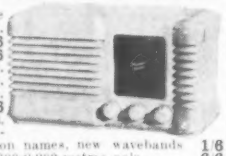
12 v. POWER SUPPLY UNIT and L.F. AMPLIFIER

A 12 v. vibrator power pack and amplifier combined. Unit contains 12 v. Mallory vibrator with filter components, 2 selenium metal rectifiers approximately 240 v. 30 mA. 1-ATP4 valve, various chokes, transformers and a host of other useful components. Housed in a metal case measuring: 11¼in. wide, 6in. deep, 4in. high.

Price 29/6, plus 5/-. Pkg. & Carr.

BUILD A PROFESSIONAL LOOKING RADIO SET AT LESS THAN HALF TO-DAY'S PRICE

We can supply all the parts to help you.

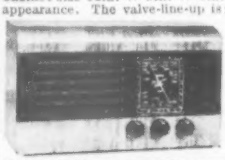


Drum (2¾in. dia.),	1/6
Drive head,	1/6
Double pointer	4d.
Spring	3d.
Nylon Cord (yard)	6d.
Dial Front Plate	2/6
Engraved Glass Dial, 180-550 and 800-2,200 m. With station names, new wavebands	1/6
T.R.F. Coils, 180-550, 800-2,200 metres, pair	6/6
Punched chassis, 3-valve plus rectifier T.R.F.	3/9
Cabinet, Bakelite, in Walnut or Ivory or Wooden in Walnut finish	17/6
Packing and Insurance	2/6

SEND 1/6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver illustrated above.

THE COMPLETE KIT

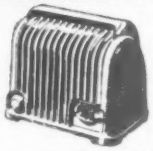
to construct a 3-valve plus rectifier T.R.F. Receiver for use on 200/250 v. A.C. mains can be supplied at **£8/9/6**, plus 2/6 packing and carriage.
Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point-to-point diagrams are supplied, making construction very simple. The Dial is illuminated, and the Receiver housed in its Cabinet size 12in. × 5in. × 6in. presents an attractive appearance. The valve-line-up is: 717A—H.F. Pentode, VR116—Detector, APT4—Output, and Metal Rectifier.



Waveband coverage is for the medium and long bands. Choice of 3 Cabinets: Bakelite in Walnut or Ivory, or Wooden (Walnut finish).

ONLY A FEW LEFT—*BUY NOW!* THE FAMOUS 'SOBELL' 4 VALVE SUPERHET TABLE RECEIVER

M. & L. WAVEBANDS



Valve Line-up 12J7, 35L6, 1487, 35Z4.
Entirely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.
Choice of 5 Colours—Walnut, Pastel Peach, Ice Blue, Aero Green, Magenta.
Carrying handle incorporated in design. For use on 200/250 A.C./D.C. mains.

Plus 5/- Pkg./carr./Ins. **£8 . 19 . 6**

Covered fully by Manufacturer's Guarantee

FOR 'HI-FI' ENTHUSIASTS

QUALITY LOUDSPEAKERS

We have a small quantity available at pre-Purchase Tax price.
GOODMANS 12in. 15 ohms imp. ..... **£8 . 8 . 0**
VITAVOX K12/20, 15 ohms imp. ..... **£11 . 11 . 0**
Packing and carriage on each of the above 5/-.
These are all BRAND NEW and in manufacturers' original carton.

CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and disc recording and sound projectors. Price **22/6**.

MOVING COIL MICROPHONE

Low impedance. Incorporates press-to talk switch. Housed in strong black bakelite case. Dimensions: 2in. wide, 2¼in. high, 1¼in. deep.

Plus 1/6 post and packing **19/6**

A matching transformer for high impedance can be supplied at **3/6** extra.

POWER SUPPLY UNIT No. 7

Ref. ZA17571. A complete Unit for charging 6-volt Accumulators, by hand. Designed for the W-S21 could be used for many other purposes. Consists of a stout metal case, dim. 17×10½×7¼in., with detachable lid, containing hand driven generator, with gear mechanism which delivers 6 volts D.C. at 4 amps., also 6 volt cut out and battery clamp. **Price 32/6**, plus 5/- post/pkg.

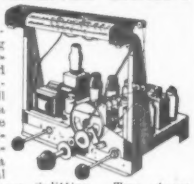
ROTARY CONVERTER POWER SUPPLY UNITS.

12 v. D.C. Input. 230 v. 30 mA Output. Completely smoothed. Complete with case, **19/6**. Plus Pkg. and Carr. 5/-.

ACCUMULATORS

By world-famous maker, 2 volt 10 amp. **4/11**

A WORLD-FAMOUS Manufacturer's Surplus of RADIO RECEIVER CHASSIS 7-valve RECEIVER



Built to exacting specifications and incorporating features ensuring superlative tonal qualities and world-wide reception. Specification: 8 watts push-pull output using 2 Mazda Pen. 45 valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HL41DD gives signal Detection A.V.C. and Phase Splitting. Two stages of I.F. amplification 465 Kc/s., using Mazda VP41. **FOUR WAVEBANDS—14 M.-24 M., 24 M.-55 M., 190 M.-600 M., 900 M.-2,000 M.**
DIRECT AND VERNIER TUNING. Gram. position on Switch. Provision for external Loudspeaker. For use on 200/250 A.C. Mains. **£13/10/-**, plus 21/- pkg. and carr.

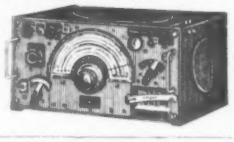
1124 RECEIVER UNIT

Range 30 to 40 Mc/s. Contains six new Valves. 3-9D2, 1-8D2, 1-15D2 (frequency changer), 1-4D1 24 ceramic trimmers, 6 ceramic valve-holders, 6 valve screening cans, 30 resistors, 1-W/W Pot. Meter Mica Tubular and Block Condensers, Ceramic coil former, 2 Westector WX6 and 1 Westector WX4, 5-way 4-bank switch with long spindle, I.F. transformers, etc.
Brand new in maker's carton at **17/6**, plus 3/6 postage and packing.

R1132A RECEIVER. Complete with valves **£3 19 6**.
Plus pkg. & carr. 10/6.

1155 RECEIVER UNIT

BRAND NEW



In original cases, complete with 10 valves. Frequency range 18.5 Mc/s-75 Kc/s. in 5 wave bands, **£11/19/6**. 10/6 packing and carriage.

POWER SUPPLY UNIT

for above incorporating output stage. Supplies an output of 250 volts at 80 mA., which is ample for the R1155 with the output stage. Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6½in. speaker is built into the unit. **Price £5/5/-**, plus 5/- packing and carriage.

As a special offer, power supply unit including speaker together with R1155 receiver.
PRICE £16.19.6, Plus 15/- pkg. & carr.

★ *We now have available a small quantity of used R1155 Receivers. We can offer these at the ridiculously low price of* **£9/19/6**, *plus 10/- pkg., Carr., Ins. These Receivers have been reconditioned and Air Tested and are fully guaranteed to be in perfect working order.*

R1355 RECEIVER AMPLIFIER

with 5 I.F. Stages for T.V. conversion. Contains 7 VR65's, 1—5U4, 1—VU120, 1—EA50, **£1/19/6**. Plus. pkg. and carriage 10/-.

RF 25 UNITS

Frequency covered 40-50 Mc/s (6-7.5 metres) switched tuning. 5 Pre-set positions complete with 3 VR65's. **£1/5/-**. Plus, pkg. and carr., 2/6.

RF 26 UNITS

The ideal short-wave converter for T.V., variable tuning, contains 2—EF54, 1—VR137, **£2/19/6**. Plus pkg. and carr. 2/6.
**As a special offer we can supply the R1355 complete with RF.24 or RF.25 at 59/6, or with RF.26 at £4.17.0, plus carr.*

R3136 RADAR RECEIVER UNIT

Containing 19 valves, 6—VR65, 2—6J7G, 2—VR116, 3—6Q7G, 1—VR54, 1—VR137, 2—VR136, 1—VR92, 1—5Z4G, the Unit Incorporates an R.F. strip followed by an IF strip, **£5/7/6**. Plus, pkg. and carr., 10/-.

R3170A RECEIVER UNIT

Brand New and Unused

This is a 16-valve VHF Receiver incorporating a 30 Mc/s. I.F. Stnip. Valve line-up: 2-CV66, 1-VU39, 2-EA50, 1-CV188, 1-VR137, 1-VU134, 8-EF50 valves. Price **£4/2/6**, plus 5/- pkg. and carr.

APN4 RECEIVER UNIT

Containing 1—6SN7, 4—6SK7, 1—6SA7, 1—VR105, 1—6H6, 1—6SL7, 1—5U4G, 3—6B4G, 2—2X2, 1—6SJ7, **£5/5/-**. Plus, pkg. and carr., 7/6.

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210 ,,	119 ,,
220 ,,	122 ,,
230 ,,	134 ,,
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.25 A	1½	2½ round ..	R.F. Thermo ..	7/6
3 A	1½	2½ round ..	R.F. Thermo ..	7/6
3.5 A	1½	2½×2½	R.F. Thermo ..	7/6
4 A	1½	2½×2½	R.F. Thermo ..	7/6
5 mA	2	3½ round ..	Centre zero ..	10/6
8 A	1½	2½×2½	M/C	12/6
20 A	1½	2½ round ..	M/C	8/6
30 A	1½	2½×2½	M/C	8/6
40 A	1½	2½ round ..	M/C	8/6
1.5 mA.....	1½	2½ round ..	.....	12/6
5 mA	1½	2½×2½	M/C	8/6
6 mA	2	3½ round ..	.....	16/9
50 mA	1½	2½×2½	M/C	8/6
100 mA	1½	2½×2½	M/C	8/6
5 A	1½	2½×2½	M/C	10/6
500 Micro/a..	1½	2½ round ..	M/C	15/-
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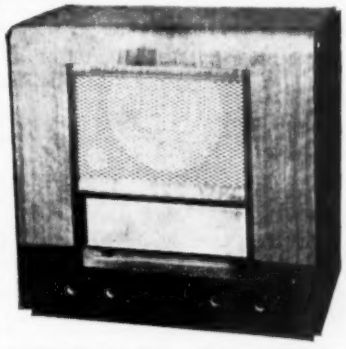

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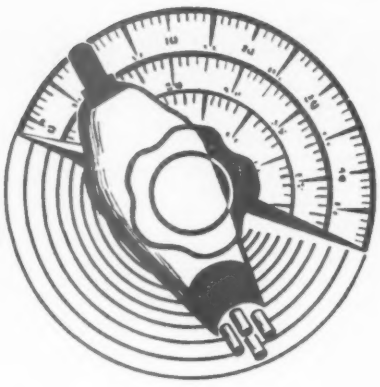

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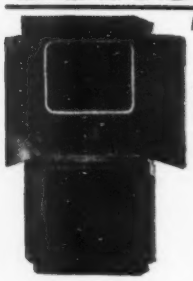

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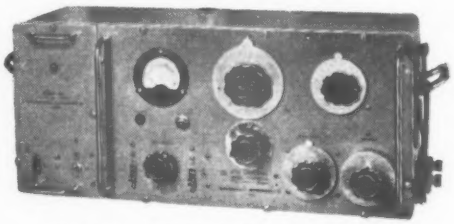

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5T4 5U4G 5V4G 5X4G 5Y3G 5Y3GT 5Y4G 5Z3 5Z4G 6A6 6A7 6A8G 6A8GT 6AB7 6AC7 6AG5 6AG6/G 6AJ5 6AK5 6AK6 6AL5 6AM5 6AM6 6AQ5 6AT6 6AU6 6B5 6B7 6B8 6B8G 6BA6 6BE6 6BG6G 6BR7 6BW6 6C4 6C5 6C5G 6C5GT 6C6 6C8G 6D6 6D7 6E6 6F5 6F5G 6F5GT 6F6 6F6G 6F6GT 6F7 6F8G 6G6G 6H6 6H6G 6H6GT 6J5 6J5G 6JGT 6J6 6J7 6J7G 6J7GT 6K6G 6K6GT

6K7 6K7G 6K7GT 6K8 6K8G 6K8GT 6L5G 6L6 6L6G 6L7 6L7G 6N5 6N6 6N7 6N7G 6N7GT 6P7G 6Q7G 6Q7GT 6R7 6R7G 6R7GT 6SA7GT 6SC7 6SF5 6SF7 6SG7 6SH7 6SH7GT 6SJ7 6SJ7GT 6SJ7Y 6SK7 6SK7GT 6SL7GT 6SN7T 6SQ7 6SQ7GT 6SS7 6ST7 6T7G 6U5G 6U5 6G5 6U7G 6V6 6V6G 6V6GT 6X4 6X5G 6X5GT 6Y6G 6Y7G 6Z5 7A4 7A6 7A7 7B6 7B7 7BP7/CV884 7C4 7C5 7C6 7C7 7D3 7D5 7D8/ARP9 7E5

7E6 7E7 7G7 7H7 7Q7 7R7 7S7 7W7 7Y4 8D2 9D2 9D6 10Y 10D1 11D3 11D5 12A6 12A6GT 12A8GT 12AH7GT 12AT6 12AT7 12AU6 12AU7 12AX7 12BA6 12BE6 12C8 12H6 12J5GT 12J7GT 12K7GT 12K8 12K8GT 12Q7GT 12SA7 12SA7GT 12SC7 12SG7 12SH7 12SJ7 12SJ7GT 12SK7 12SK7GT 12SL7GT 12SN7GT 12SQ7GT 12SR7 12U5G 12X3 12Y4 14A7/12B7 14B6 14E7 14H7 14K7 14S7 15E 15R 19AQ5 25A6G 25L6 25L6GT 25Y5 25Z4G

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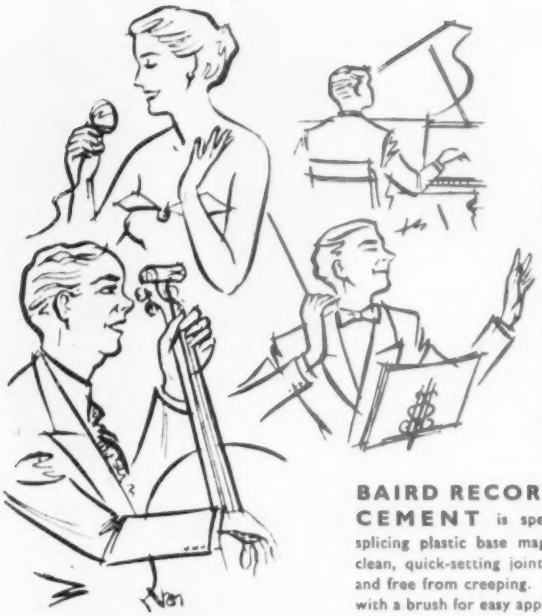
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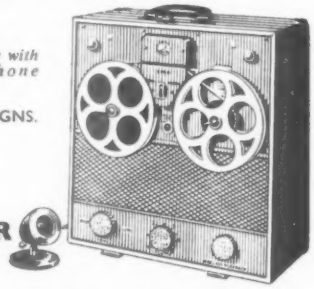

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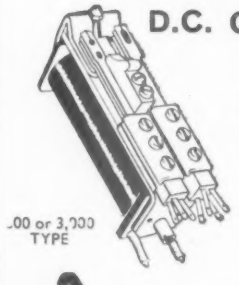

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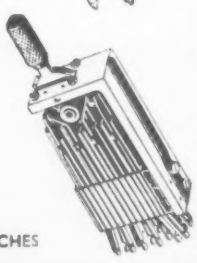

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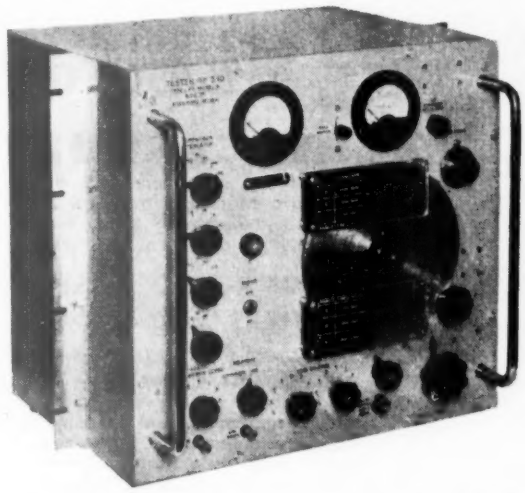

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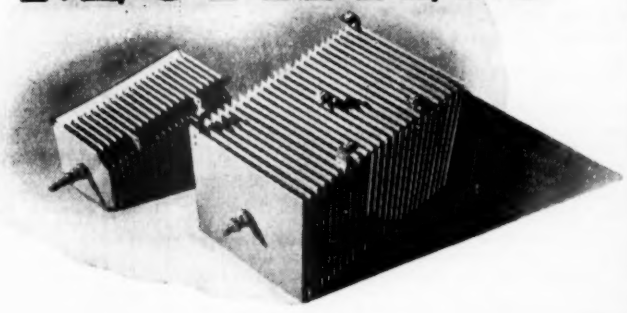

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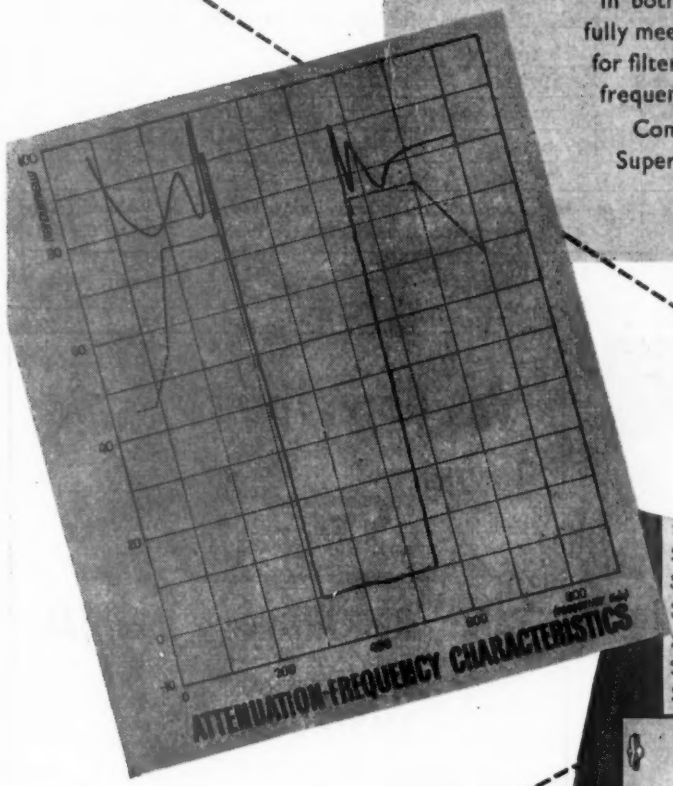

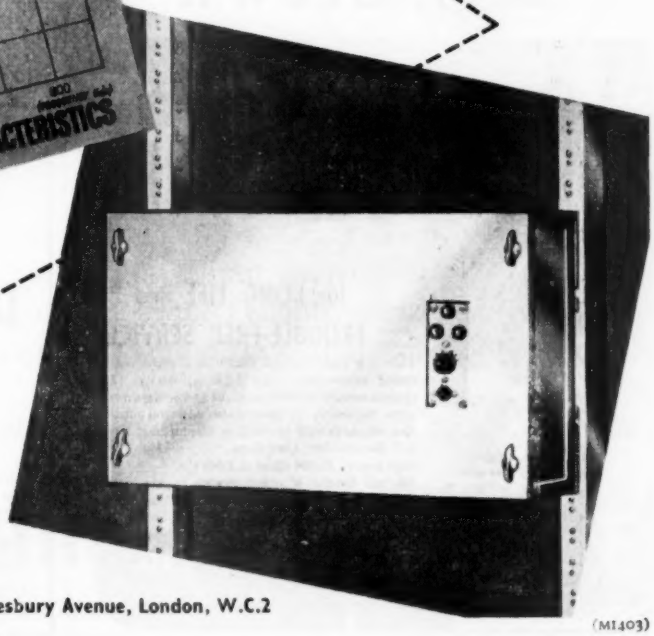

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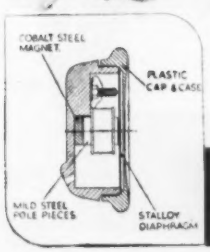

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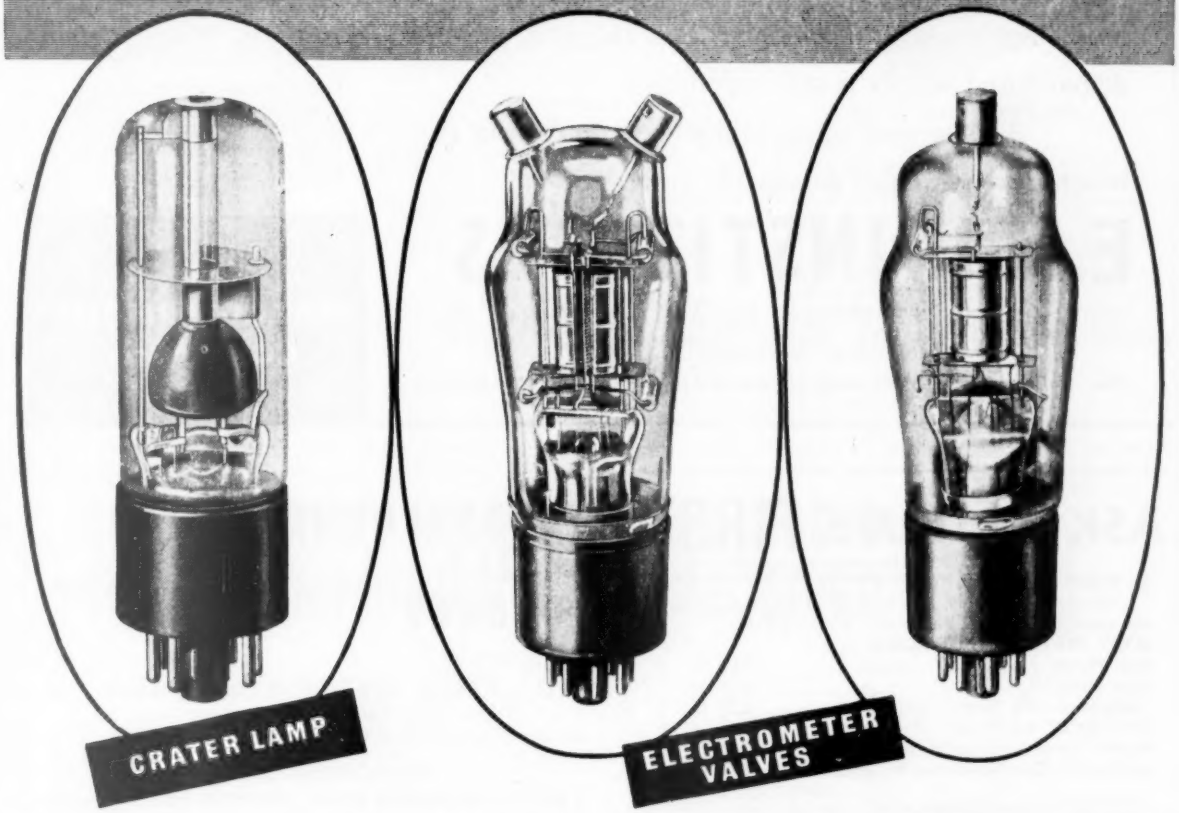

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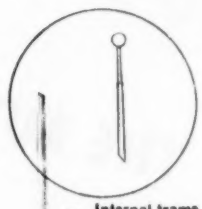

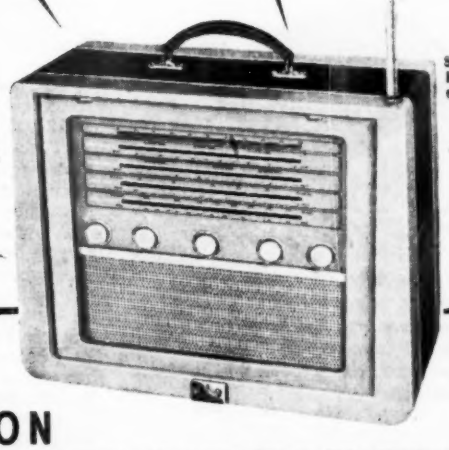
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FEBRUARY 1953

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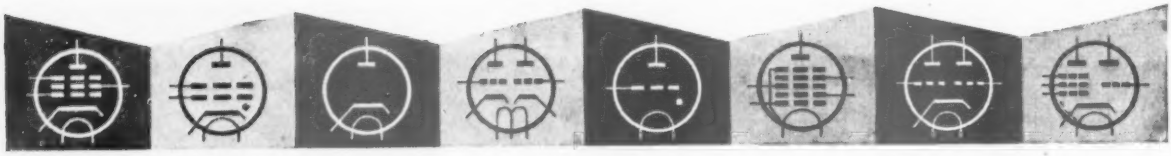

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The Mullard ECL80 is a combined triode and output pentode having a single cathode which is common to both sections. Among its numerous applications is the use of the pentode section as an audio power amplifier preceded by the triode section as a voltage amplifier. With an h.t. line voltage of 200V, a simple single-valve amplifier having no feedback arrangements can deliver 1.4W power output at a total harmonic distortion of 10%.

This output may not be sufficient for domestic requirements, particularly if feedback is introduced to reduce the distortion. In particular, it may be desired to take advantage of the better quality sound transmitted in the television service. This can be accomplished by using a push-pull output stage. A simple, economical circuit in which the output stage is combined with a suitable voltage amplifier and phase inverter can be constructed with two ECL80's.

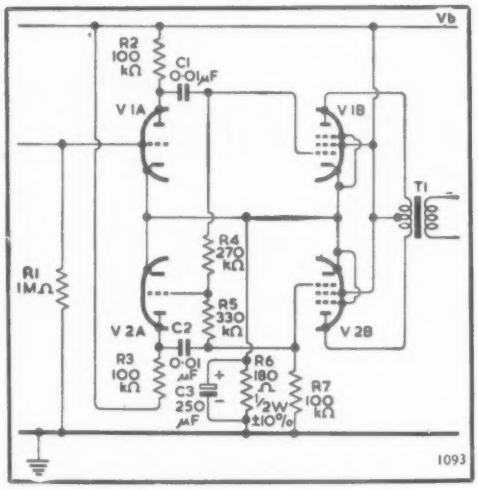

Fig. 1 Circuit diagram of amplifier.

A circuit diagram for the amplifier is given in Fig. 1. With an h.t. (Vb) of 200V, a power output of 3W may be obtained with a total distortion of approximately 3% from an input of 0.6V r.m.s. to the amplifier. This input voltage is small enough to be supplied direct from the demodulator of a receiver even when negative feedback is incorporated in the amplifier in order to reduce the distortion. The circuit is stable and free from self-oscillation at all frequencies. In addition it has been designed so that the total current consumption changes as little as possible from no-signal to full output conditions. This ensures good output and low distortion if the circuit is operated from a power supply having poor regulation. It also reduces the effect of the amplifier upon other circuits working from the same power supply.

Mullard

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MULLARD LTD., Technical Publications Department, Century House, Shaftesbury Avenue, W.C.2.

MVM218

Wireless World

FEBRUARY 1953 VOL. LIX No. 2

Alternative Television Service

WHEN the Government's proposals for an alternative television system, independent of the B.B.C., were announced last summer, *Wireless World* ventured to criticize them as unrealistic—as something for the dim and distant future. We may have been wrong in that opinion, but some seven months have now elapsed, and the project is certainly at least one stage further from fruition than when it was launched. At that time the Government announced that the start of independent television would be contingent, among several other things, on completion of the B.B.C.'s system for nation-wide coverage. A month or so ago, it was announced that authority to erect the five B.B.C. low-power stations that are part of the scheme must be postponed indefinitely. And the starting of competitive television is contingent on many other things.

Not only must the B.B.C. television system be completed according to plan, but a B.B.C. sound broadcasting service on v.h.f. must be at least initiated. And before this v.h.f. service can start, the Postmaster-General must be advised by the Television Advisory Committee, which is also charged with the task of advising him on the conditions for competitive television. *Wireless World* has already criticized the composition of the T.A.C., and we shall be indeed surprised if it produces an immediate solution of the delicate problems with which it is confronted. When these preliminaries are disposed of, the licensing of competitive stations must be debated in Parliament, presumably with all the party-political acerbity that accompanied the proceedings on the renewal of the B.B.C. Charter. Until all these things are done, it would surely be unwise to start the manufacture of a single piece of transmitting apparatus.

If to-day we lack the national resources to complete the B.B.C. chain, is it reasonable to expect an overnight change enabling us to afford a complete independent system? *Wireless World* suggests a less grandiose experimental start of competitive television—the leasing of time on the B.B.C. network to commercial organizations. Need the B.B.C. stations be sacrosanct? In all probability the Corporation would, in fact, welcome the substantial increase in its income that could be earned in this way. This is not a new idea; it was brought forward by Sir Ian Fraser during the B.B.C. Charter debate, and, according to newspaper stories, has recently been revived. We can get no confirmation of the report that there is influential Government support for this scheme, but it would at least allow an early trial without heavy capital commitments.

Non-broadcast Television

ACCORDING to a report from New York last month, a performance from the Metropolitan Opera House there was relayed by television to nearly 30 American cities, and shown to paying audiences on full-sized screens in cinemas. An American correspondent who amplified the report for us says distribution was through the radio relay systems and r.f. cables normally used for linking television broadcast stations. The projection apparatus for the cinemas was produced by R.C.A. and the normal 525-line American standards were used. The show was not broadcast.

What interests us about this story is not so much the technical achievement as the comparison with conditions obtaining in this country. Here, although big-screen television attained a high state of technical development several years ago, it has never been shown to a paying audience, at any rate on a commercial scale. The Post Office has consistently refused to license radio distribution of television to cinemas, apparently on the grounds that it necessarily conflicts with broadcast television. In America, on the other hand, there were no "political" obstacles to what appears to have been a highly successful trial of a new technique. As "public carriers," the owners of the radio relay networks and r.f. cables handled the television signals like any other kind of traffic. The experiment will at least show our Post Office that television in the cinema has not of necessity any connection with broadcast television. It seems a pity that we have to learn this lesson from abroad.

New High-Grade Condenser Microphones

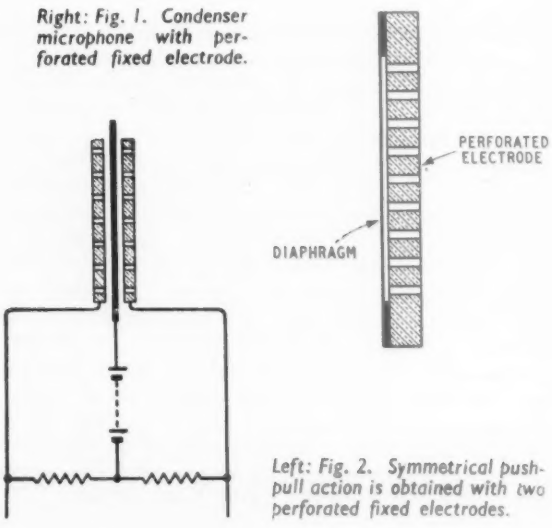
1 — Considerations Leading to the Design of Recent Neumann Types

By F. W. O. BAUCH

AN essential part of all conventional microphones is the diaphragm, which responds by vibration to periodical forces in the surrounding field of sound. The transformation of the diaphragm movements into electrical energy can be achieved by various principles, the most important, as far as modern broadcasting and recording studio technique are concerned, being the electro-magnetic and the capacitive. Moving-coil and ribbon microphones represent the first, condenser microphones the second.

The moving-coil microphone, mainly used for speech or outside broadcasts, is always made as a pure sound pressure receiver, i.e., it responds to periodical variations of air pressure under the influence of a field of sound. Sound pressure is of scalar magnitude, therefore pressure microphones have an omni-directional sensitivity, actually a spherical characteristic with equal e.m.f. output, which can conveniently be expressed as a sectional plan in the form of a circle with the diaphragm vertically in its centre. Ribbon and condenser microphones can be made to follow the same polar diagram pattern, but more often they are built to act as receivers with decidedly directional characteristics, either in the form of a figure of "8" or of a cardioid (heart-shaped) polar response. Ribbon microphones incorporating such characteristics are widely used in this country, and it can be assumed that the principles of their response to sound pressure and/or sound pressure-gradient (also referred to as "pressure difference" and "velocity") are well known. But it may not be so widely known how cardioid characteristics were achieved with condenser microphones.

Right: Fig. 1. Condenser microphone with perforated fixed electrode.



Left: Fig. 2. Symmetrical push-pull action is obtained with two perforated fixed electrodes.

In principle, a condenser microphone consists of a more or less tightly stretched metal foil (diaphragm) in front of and electrically insulated from a fixed flat metal electrode, thus forming a condenser. A polarizing voltage connected via a high-value resistor completes the system. The change of capacitance consequent upon movement of the diaphragm produces an alternating voltage across the load resistor.

As early as 1935, v. Braunmühl and Weber[1] described methods designed to modify the hitherto purely pressure-type condenser microphone into a pressure-gradient type with directional characteristics of the figure-of-eight and the cardioid.

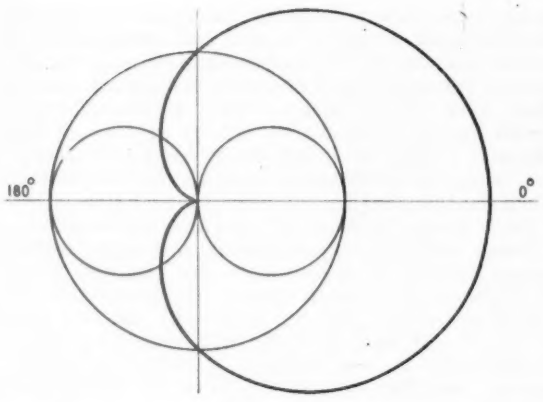
Braunmühl and Weber Principle.—The normally solidly built fixed electrode which prevented the excitation of the diaphragm by sound waves from its back is replaced by a similar electrode with a number of perforations in the form of small round holes (Fig. 1). Both sides of the diaphragm are now exposed to the field of sound, the driving force is now changed from one-sided sound pressure to the sound pressure-difference between front and back of the diaphragm. Accordingly, the maximum sensitivity will be perpendicular to both surfaces of the diaphragm, decreasing towards side-excitation with the cosine of the angle of incidence. The relationship is expressed: $e = \sqrt{e_0^2 \cos^2 \alpha}$, where e_0 is the sensitivity at maximum excitation and α is the angle incidence.

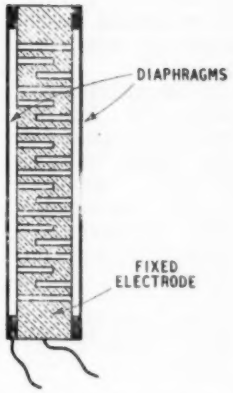
The magnitude of the effective pressure gradient depends on the wavelength of the sound and on the physical size of the microphone, actually on the distance from the middle of the diaphragm in front to the middle of the back, via the edge of the microphone capsule.

There is also the possibility of producing a completely symmetrical microphone by adding another similarly shaped perforated electrode on the so far unoccupied side of the diaphragm. There need not be any electrical connection to this second electrode, but if used it should be connected in push-pull, as shown in Fig. 2, in order to relieve the diaphragm of electrostatic attraction and to take advantage of the increased sensitivity, which is doubled.

Cardioid Characteristic.—It was known at the time how to combine two microphones with omni-direc-

[1] v. Braunmühl and Weber, *Hochfrequenztechnik u. Elektroakustik* Vol. 46 (1935) pp. 187-192.





Left: Fig. 3. Construction of a cardioid by the addition of circular and figure-of-eight characteristics. Right: Fig. 4. Diametral section of cardioid-type condenser microphone.

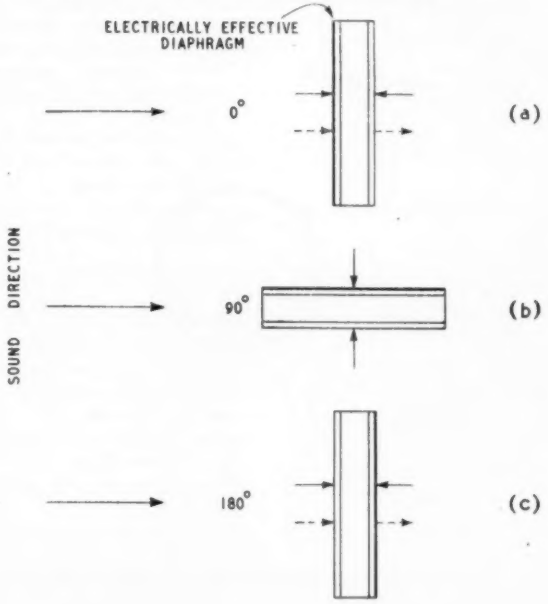
tional and figure-of-eight characteristics into a single sound receiver with a polar diagram of cardioid shape.[2] Such combinations are used in modern ribbon-type microphones, where one-half of the ribbon acts as a pressure-gradient receiver, while the other half, backed by a specially designed sound chamber, works as a pressure receiver. Fig. 3 shows the construction of a cardioid by combining circular and figure-of-eight polar diagrams. It is essential, however, that the sensitivity of both halves of the ribbon should be equal for their respective characteristics, i.e., the circle must exactly enclose the figure-of-eight. Simple addition and subtraction of all vectors, taking into account their respective directions, shows the ideal cardioid, with its mathematical expression: $e = e_0 (1 + \cos\alpha)$. The cardioid characteristic can be provided by the condenser microphone principle by fixing two equal diaphragms to both sides of a perforated fixed middle electrode which, moreover, is also supplied with a number of cavities on both sides (Fig. 4). The flexibility of both diaphragms is such that their initial stiffness need not be taken into consideration when compared with other existing resistances, and the great stiffness of the air inside the perforations can be regarded as a very tight coupling between the two diaphragms of which one is electrically ineffective.

The mechanical operation under the influence of sound can be explained in the following way. The sound pressure is a force which tends to move the two diaphragms towards each other against the compression of the enclosed air pocket. At the same time, the pressure gradient tries to move the enclosed air pocket to and fro by exciting the two diaphragms in co-phase movements and to force the enclosed stiff air through the holes from one side to the other. The resulting movement can be seen in the much-simplified drawing of Fig. 5 (a), in which the approach of the sound comes from the left. The two forces add on the left and on the electrically effective diaphragm (thick line) and cancel each other on the right-hand side of the capsule with the electrically ineffective second diaphragm (thin line). Fig. 5 (b) shows the sound approach from the side, with the pressure component alone having an effect. Fig. 5 (c) has the sound approach from the back, i.e., unto the electrically inactive diaphragm, and shows the two forces on the right-hand diaphragm opposed to each other. It must be emphasized that this explanation is much simplified for the sake of showing the principle in great clearness. Fig. 6 shows a more modern version of the "Braunmühl-Weber" cardioid capsule.

Recent Developments.—Microphones are the first link in the chain of apparatus necessary for the distribution of sound impressions. Any deficiency here cannot easily be improved in later links. The sound engineer must therefore have microphones at his disposal which are able to convey a favourable sound picture, and which can cope with the various difficulties in complicated musical assemblies. Modern microphones, furthermore, must answer to very high demands in frequency response, linearity, and freedom from noise—and the number of types should be limited to very few.

Twenty years of continuous experience with con-

Fig. 5. Equivalent forces acting on the cardioid microphone for various directions of the source of sound. Full arrows, forces originating from sound pressure; broken arrows, forces originating from pressure gradient.



Below: Fig. 6. Neumann cardioid condenser microphone capsule, Type M7.

[2] Weinberger, Olson and Massa; *J. Acous. Soc. Amer.*, Vol. 5, p. 139.

denser microphones in German broadcasting, and the application of modern ideas in the technique led to the development of two new microphone types with a number of very interesting properties.[3]

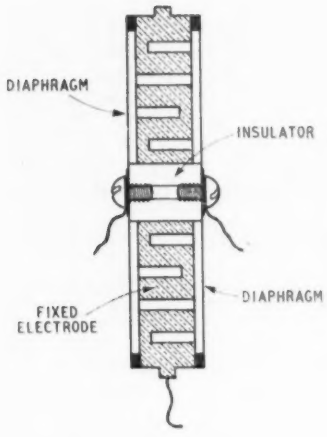
The demand for a choice of directional microphones could be fulfilled with the creation of one single novel pressure - gradient type microphone with adjustable characteristics. This microphone (Neumann Type M49) provides the possibility of changing its directional sensitivity at will and continuously by remote control, and it possesses an extremely flat frequency response which is widely maintained over its three main characteristics. Any section of a concerted musical performance can be picked out with objective truthfulness, and the result is also satisfactory where the direct sound outweighs the indirect, i.e., when receiving from a relatively short distance, where a flat response becomes of particular importance.

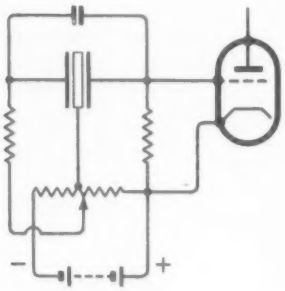
[3] H. Grosskopf, *FTZ* (Sept., 1951); p. 398; *Techn. Hausmitt. des NWDR*, Vol. 3 (1951), p. 172.

Left: Fig. 7. Neumann Type M49 condenser microphone with continuously adjustable directional characteristics.

Below left: Fig. 8. Simplified section of Neumann Type M49 microphone capsule.

Below: Fig. 9. Electrical connections of M49 microphone.





Large philharmonic orchestras, and other widely spread sources of sound, force the receiving single microphone to a much greater distance from the source of sound, into the practically diffused field of sound. At this great distance, pressure-gradient microphones do not produce a really satisfactory quality, and the reproduction is of an exaggerated hollowness.

Good results, on the other hand, were always achieved with omni-directional microphones which become directional with increasing frequency. This progressive change from an omni-directional to a directional characteristic goes automatically hand in hand with a rising sensitivity to frontal sound waves. But the directional effect must also not be too pronounced in order to give a good reception of large sound sources, and must be equally good for all frequencies.

These reflections led to the development of a pressure-type microphone (Neumann Type M50) with gradually rising frequency response (+5db at 15 kc/s), going directional at the same time with a still very wide characteristic at the highest frequencies.

These microphones M49 and M50, developed in collaboration with the Acoustics Laboratory of the Nordwestdeutsche Rundfunk, seem to satisfy all demands in sound broadcasting, and the range of necessary microphones for any purpose could be limited to two types only.

Adjustable Directional Characteristics.—The principle of the Neumann Type M49 microphone (Fig. 7) is a combination of two equal cardioid condenser systems with their maximum sensitivity in opposite directions. Fig. 8 gives a simplified version of the construction. Both systems work into a common single-stage amplifier, the front one being energized by a constant voltage, while the other receives its voltage via a potentiometer, the setting of which

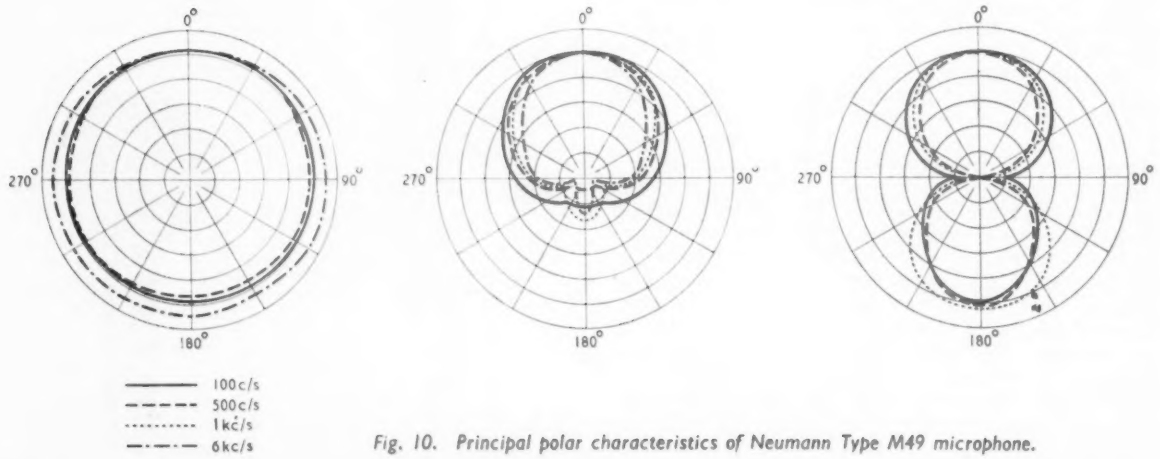


Fig. 10. Principal polar characteristics of Neumann Type M49 microphone.

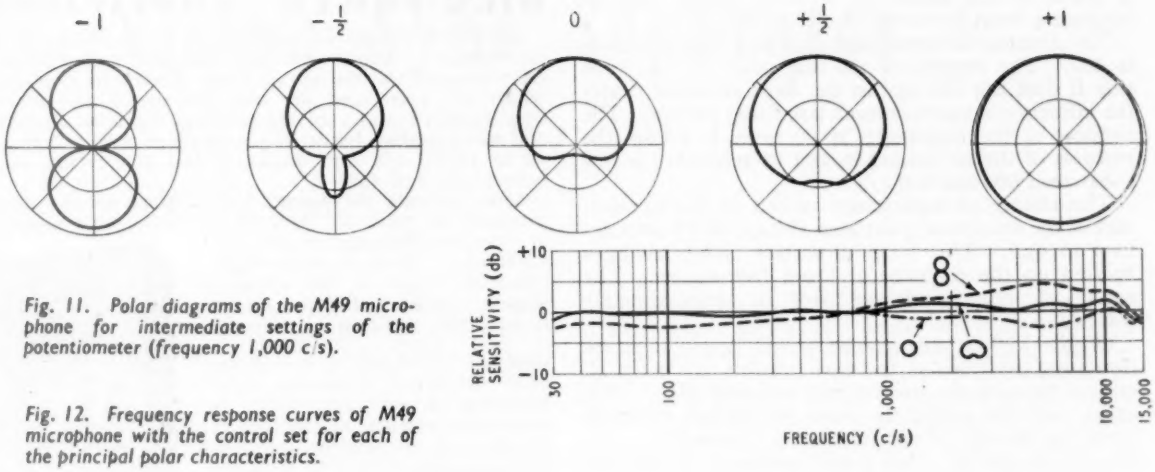


Fig. 11. Polar diagrams of the M49 microphone for intermediate settings of the potentiometer (frequency 1,000 c/s).

Fig. 12. Frequency response curves of M49 microphone with the control set for each of the principal polar characteristics.

determines the directional characteristic of the combination. Fig. 9 shows the connections, with the slider in the middle, giving a cardioid characteristic. As the slider is moved to the right the cardioid changes gradually to the omni-directional characteristic, with the same voltage applied to both systems; as it is moved to the left the diagram changes into a figure-of-eight, with reversed voltage. Normally, the potentiometer is housed in the mains unit, which will be described later.

Fig. 10 shows polar diagrams of the three principal directional characteristics at selected frequencies. Fig. 11 shows what happens to the characteristic at intermediate settings of the potentiometer. The frequency response curves for each of the three characteristics is shown in Fig. 12. Other relevant electrical characteristics are as follows: *Frequency response*, 40-15,000 c/s; *output impedance*, 200 ohms; *sensitivity*, approx. 0.7mV/microbar (dyne/cm^2); *overall noise*, $<2\mu$V ($<$22 phon).

As will be seen in Fig. 13, the microphone capsule is flexibly mounted on the top of a Perspex cover, which houses all essential parts of the single-stage amplifier. Cover, amplifier and base-plate can be easily detached for servicing.

The relatively small capacitance (75-80pF) makes it essential to build microphone and amplifier close together. The amplifier has an extremely high input resistance (150 MΩ)—necessary for feeding the condenser a.c. voltage independently of frequency to the grid of the amplifier valve, and also in the interest of low equivalent noise level which becomes less with higher input resistance.

The grid circuit and valve noise, which determines the lowest useful signal level, must not exceed 1 to 1.5 μV. To this end a special valve, Type MSC2, was developed. This has a directly heated oxide-coated cathode and is soldered directly into the circuit wiring.

Fig. 14 shows two of the component parts of the Type M49 microphone capsule. On the left can be seen one of the polyvinyl chloride diaphragms with a thickness of only 8 μ (μ=1/1,000 millimetre), and coated on one side by a sputtering process with pure gold having a thickness of 0.3 μ. On the right is the partly perforated middle electrode. When mounted on either side of the fixed electrode the effective diameter of the diaphragm becomes 28mm. The diaphragm vibrates in the form of a ring and contact

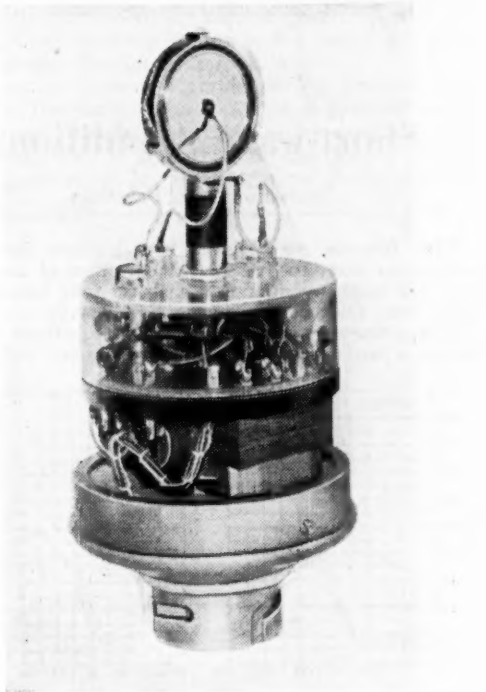


Fig. 13. Neumann Type M49 microphone with cover removed.

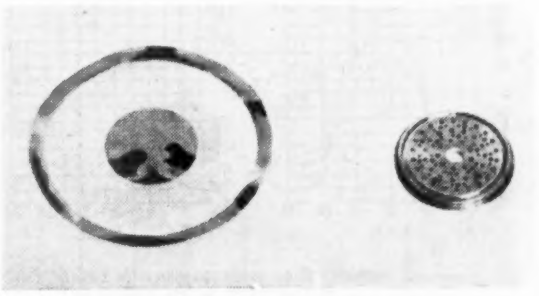


Fig. 14. (Right) Fixed central electrode, and (left) one of the gold-sputtered p.v.c. diaphragms before mounting.

is made to the centre by a screw fitting into an insulating bush in the fixed electrode.

The distance between diaphragm and fixed electrode is 40μ. The tension of the diaphragm is just such that it does not fall against the fixed electrode under the influence of the maximum polarizing voltage. The stiffness of the diaphragm is 60 times l s than the stiffness of the air behind it, and its resonance is low —between 600 and 800 c/s.

The change of capacitance caused by the application of the maximum polarizing voltage (60V) amounts to 3 to 4pF. This is an important factor having a bearing on the response at lower frequencies. The e.m.f. of one condenser side is approximately 1.4mV/μb.

Of the highest importance is the employment of insulating materials of the best possible grade for all critical parts in the microphone and amplifier. This again calls for extremely clean production methods involving the use of special cleaning materials.

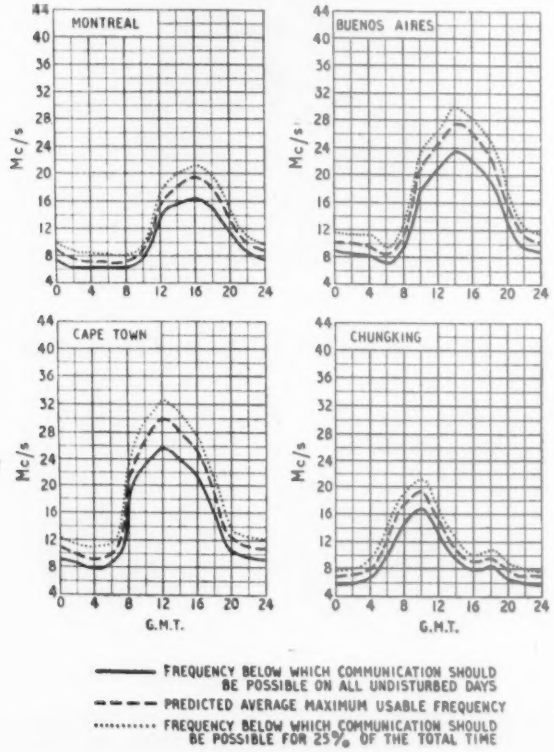
(To be concluded. Part 2 will contain a description of the Neumann Type M50 pressure-type microphone and some auxiliary apparatus.)

Short-wave Conditions

Predictions for February

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during February.

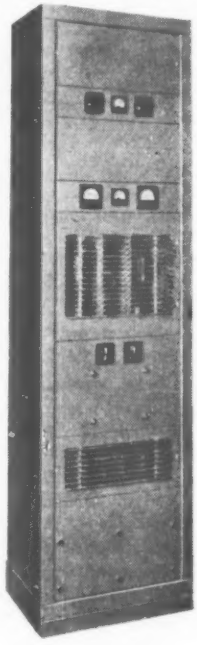
Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.


MONTREAL
BUENOS AIRES
CAPE TOWN
CHUNGKING
Mc/s
G.M.T.
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

HIGH-POWER AMPLIFIERS

OUTPUT powers of the order of a kilowatt are not uncommon in audio amplifiers designed for broadcast relay systems, and the Savage Mark II kilowatt amplifier, which has been used not only for speech and music amplification but as a driving source for vibration research and measurement, has a frequency range within 2 db of 40 to 14,000 c/s with distortion less than 1 per cent between 65 and 4,000 c/s.

More recently the Savage V.L.F. amplifier has been produced to meet the demand for comparable outputs at very low frequencies (10 c/s-1,000 c/s). It is of similar rack-mounted design to the standard kilowatt amplifier, but the output transformer, which is of necessity a very heavy component, is mounted on wheels as a separate unit. Distortion is claimed to be less than 5 per cent, which is exceptionally good having regard to the low frequencies involved. Series-parallel secondary windings give ratios to match load impedances of 2.5, 10 or 40 ohms.



The inherent frequency response at low output levels is within 5 db between 2 c/s and 4,000 c/s but at maximum output there is some falling off below 10 c/s and above 1,000 c/s.

To some extent the available power is controlled by the nature of the load and is limited to 350 watts into a purely reactive load. However, the full output of 1 kW can be obtained if inductance or capacitance is added to the load to bring the power factor to unity (resonance).

The manufacturers are W. Bryan Savage, Ltd., Westmoreland Road, London, N.W.9.

Ignition Interference

IT is estimated that, of the 4½ million motor vehicles that regularly use the roads and likely to cause interference to television viewers, only half a million are fitted with suppressors. It has been proved beyond all doubt that a suppressor does no harm to the engine and has negligible effect on the performance.

The Radio Industry Council has said that, for a start, a single suppressor in the distributor to coil lead will give adequate suppression in some 60 per cent of the offending motor vehicles, while of the remainder half will be suppressed to a just acceptable amount.

Aircraft piston engines always have resistors in their plugs to reduce plug erosion or burning; in fact, they dare not fly without them. Many experts agree that resistors in the plug lead assist cold starting of car engines, but it appears that the benefit is really only apparent at very low temperatures.

For the suppression of interference with v.h.f. radio and television any value over 5,000 ohms will suffice, and 10,000 ohms is a good compromise value. With one resistor in each plug and distributor lead a total of 20,000 ohms only is in circuit, and it has been proved that it needs from a half to one megohm to produce any noticeable effect on engine performance.

As for reliability, investigation has shown that over the past 25 years there have been only a dozen or so known failures to engine suppressors.

The above are a few of a host of interesting facts on suppression of interference contained in a paper "Current Radio Interference Problems" read to the British Institution of Radio Engineers by E. M. Lee, B.Sc., and published in the Institution's journal for November, 1952.

Television Sync Separator

With Positive-going Output Pulses

By D. CLEMENTS

THIS is a two-valve sync separator which accepts the composite video signal and effects the separation of line and frame sync pulses in such a way that these pulses are both produced with positive-going polarity. Many separating circuits suffer from the disadvantage that the separated pulses, for synchronizing either one or both of the time bases, are produced with negative-going polarity which prevents their direct application to certain types of sawtooth generators (e.g., those employing thyratrons).

The separated pulses for both line and frame time bases have vertical leading edges. In the frame circuit the edge coincides with the trailing edge of the first frame pulse. The amplitude of the separated pulses is large and independent of signal input voltage.

Since the circuit accepts video signals of negative polarity (as would be present at the anode of a video output stage which modulates the cathode of a c.r. tube) the circuit can be used to replace an ordinary type of separator.

The principle of the circuit is orthodox as far as the separation of the line sync pulses is concerned. Separation is achieved in the first valve V_1, Fig. 1, which is a pentode. This operates in the usual way as a limiter, the video signal being applied to its control grid. The output is taken from the screen and the phase of the negative pulses is changed in a second valve V_2. The separated frame pulses are derived from the anode of the first valve which is normally cut off by a bias voltage applied to the suppressor grid. The positive pulses, from the second valve, are used to unblock this anode during the first frame pulse by applying them to the suppressor via an integrating circuit. At the end of the first frame pulse the anode is cut off sharply by the control grid and a steep-fronted positive-going pulse ensues.

Fig. 1 shows the basic circuit of the separator. The video signal, of negative polarity (i.e., positive-going sync pulses), is fed to the control grid of V_1, which is driven into grid current by the tips of the sync pulses and thereby effects d.c. restoration. The anode of this valve is cut off by the suppressor which is returned to a negative bias. Due to the low h.t. the grid base of this valve is short and the picture signal is driven beyond the cut-off of the control grid, with the result that separated negative-going sync pulses appear at the screen. These pulses are fed to the control grid of V_2 and the resulting positive-going pulses at the anode are used to synchronize the line time base.

The output from the anode of V_2, besides synchronizing the line time base, is used to gate the anode of V_1 during the first frame pulse by means of the suppressor. This is done by coupling the suppressor to the anode of V_2 by an integrating circuit CR, of

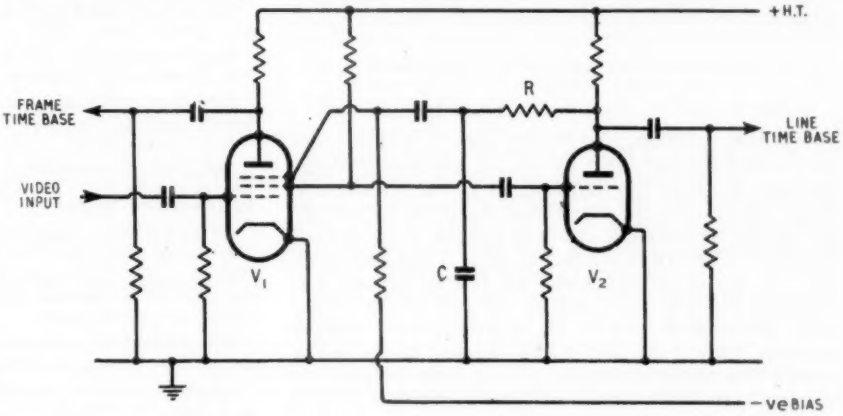
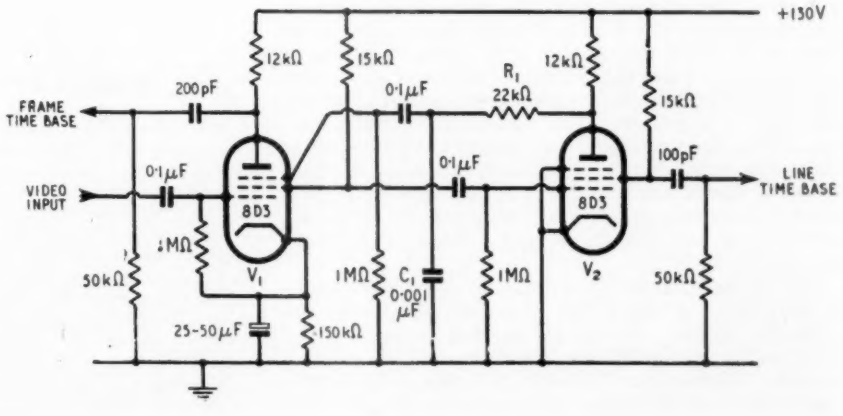


Fig. 1 (above), shows the Basic circuit, and Fig. 2 (below), the Prac ical circuit.



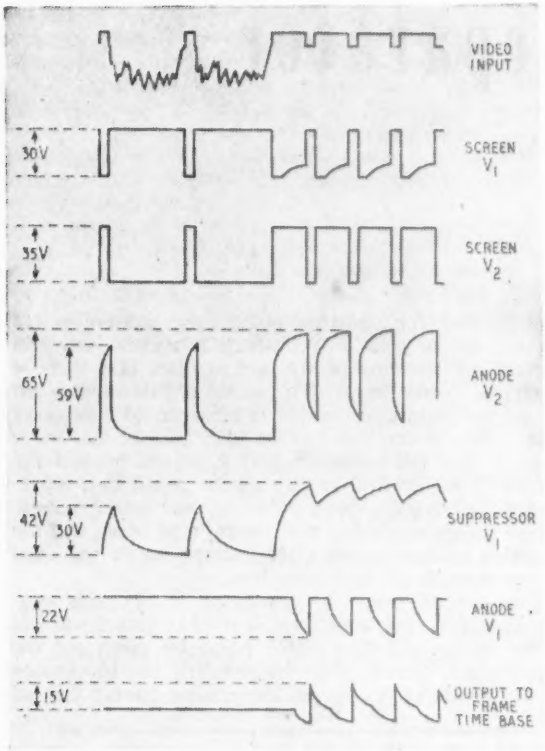


Fig. 3. Voltages and waveforms in the circuit shown in Fig. 2.

critical time constant, such that during a line pulse the positive voltage built up on the suppressor is insufficient to open the anode circuit; but during the longer frame pulse the suppressor is driven sufficiently positive for the anode to conduct and the anode potential falls. This fall in anode potential is comparatively slow, as the integrated pulse on the suppressor has a sloping leading edge, but at the end of the frame pulse the control grid of V_1 is driven very sharply negative, cutting off the anode current and thereby causing the anode potential to rise very steeply. If the waveform at the anode is differentiated this sudden rise in anode potential produces a steep-fronted positive-going pulse coinciding with the trailing edge of the frame pulse.

A practical circuit is shown in Fig. 2 using two valves of the high-slope pentode type. The bias on the suppressor of V_1 is derived from a bypassed cathode resistor, the control grid being returned to the cathode. Since the second valve is also a pentode, the screen is a convenient place from which to obtain the line sync pulses. The integrating circuit R_1C_1 has a time constant of 22 μsec which gives the largest difference in amplitude resulting from the application of either line or frame pulses. A line pulse of 10 μsec reaches approximately 0.5 of its amplitude across C_1 and a frame pulse of 40 μsec approximately 0.85 of its amplitude.

If it is desired to use this circuit with other types of valve (e.g., EF50, EF54, etc.) the only change required is in the value of the cathode resistor of V_1 to allow for any difference in suppressor-grid characteristics. The correct value for this resistor may quite easily be found by temporarily substituting a variable resistor in the cathode of V_1 and adjusting for the largest value of resistance that gives a reliable frame hold and finally replacing it with a fixed resistor of suitable value. Care must be taken that sufficient time elapses between different settings of the resistor for V_1 to reach a steady working condition, for the time constant in its cathode is fairly high.

Fig. 3 indicates the various voltages and waveforms that can be expected at different parts of the circuit. The average cathode currents of V_1 and V_2 are approximately 0.3 mA and 8.0 mA respectively.

SOCIETIES AND CLUBS

Additions and Amendments to our Directory †

BIRMINGHAM.—Birmingham and District Short Wave Society.—A. O. Frearson, 66, Wheelwright Road, Erdington, Birmingham, 24.

CHESTER.—Chester and District Amateur Radio Society.—New Sec.: N. Richardson, 1, Victory Villa, Newton Lane, Upton, Chester.

HASTINGS.—Hastings and District Amateur Radio Club.—W. E. Thompson, 8, Coventry Road, St. Leonards-on-Sea, Sussex.

LONDON AREA.—British Two-Call Club.—G. V. Haylock, 63, Lewisham Hill, London, S.E.13.

Ravensbourne Amateur Radio Club (G3HEV).—W. H. J. Wilshaw, 4, Station Road, Bromley, Kent.

Sanderstead and Purley Amateur Radio Society, now Purley and District Radio Club.

MANCHESTER.—Manchester and District Radio Society.—K. Brockbank, 17, Burleigh Road, Stretford, Lancs.

PETERBOROUGH.—Peterborough Radio and Scientific Society (G3DQW).—S. Woodward, 72, Priory Road, Peterborough, Northants.

SOUTHEND.—Southend and District Radio Society* (G50K).—New Sec.: G. Chapman, Bell Hotel, 20, Leigh Hill, Leigh-on-Sea, Essex.

STOCKPORT.—Stockport Radio Society.—G. R. Phillips, 7, Germans Buildings, Buxton Road, Stockport, Cheshire.

SUNDERLAND.—Sunderland Radio and Television Society.—C. A. Chester, 38, Westfield Grove, High Barnes, Sunderland, Co. Durham.

WELLINGTON.—Wrekin Amateur Radio Society.*—New Sec.: G. N. Myatt, 12, Swan Street, Broseley, Salop.

WIRRAL.—Wirral Amateur Radio Society.*—New Sec.: L. Roberts, 18, Croxteth Avenue, Wallasey, Cheshire.

† *Wireless World*, November, 1952.
* Clubs affiliated to the R.S.G.B.

Amateur Valve Guide

IN order to help home constructors (excepting amateur transmitters) to choose the right kind of valves for a particular set or amplifier and to operate them to the best advantage, Mullard has issued a 48-page booklet "The Amateur's Guide to Valve Selection."

Abridged technical data, operating conditions and base connections of some 35 different types of Mullard valves and c.r. tubes are given. It is explained that almost all amateur requirements can be satisfied with this number. There is a useful applications section in which circuits and complete design data are given for three receivers and five amplifiers.

The valve guide is obtainable from radio and television retailers at 1s 6d.

Radio Road Patrols

Some Problems Encountered when Equipping Motor Cycle Combinations with Radio Telephones

THE first stage of a national scheme designed ultimately to provide two-way radio communication between road patrols and area headquarters was recently inaugurated by the Automobile Association.

Initially the new service will operate over an area covered by a 20-mile radius from Fanum House, the Association's London headquarters, and is a logical extension of the A.A. radio-controlled night breakdown services which have been in operation in London and the provinces for some time past. With the equipping of the daytime motor cycle patrols this area now has a 24-hour radio-controlled patrol and breakdown service in operation.

The idea of equipping A.A. patrols with radio was actually attempted before the recent war, but technical developments had not gone far enough then to make the idea practicable. Now with so much more known about mobile v.h.f. communications the scheme is capable of being brought to fruition.

Transmitter Site

Two radio frequencies in the v.h.f. band have been allotted to this service: 85.525 Mc/s for all fixed transmitters and 72.025 Mc/s for all mobiles throughout the country. The equipment is mainly Pye, although a few Marconi sets are also in use. At the London headquarters' station a Pye Type PTC703 does duty. This is located on high ground at Hampstead and is remotely controlled. It gives a power output of 15 watts and is amplitude modulated. There is a stand-by transmitter at the London headquarters for use in the event of equipment failure at Hampstead, or trouble with the land lines.

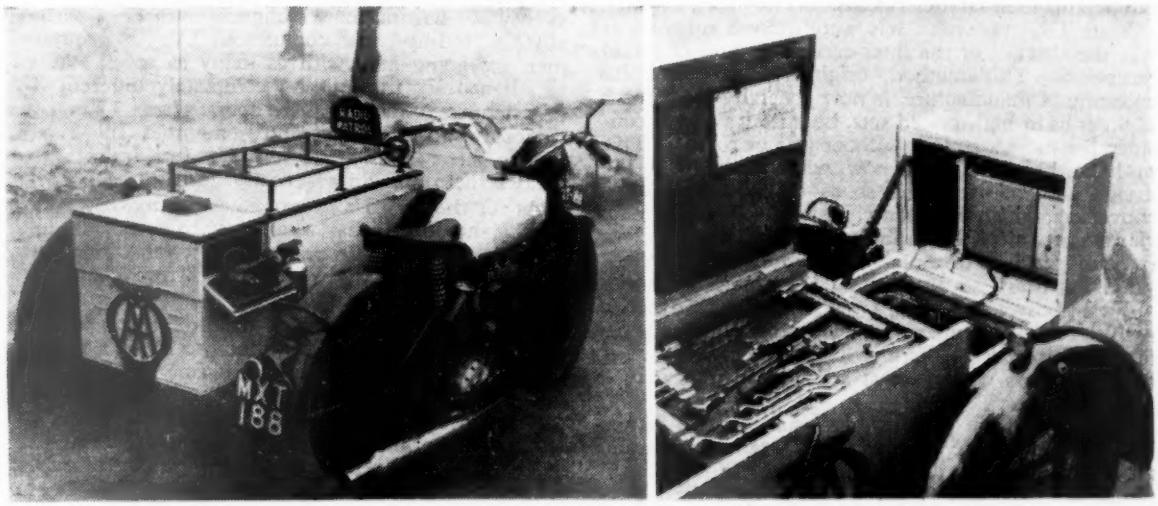
The mobile sets are Pye "Reporter" Type PTC116 giving about 2.5 watts output. The equipment is housed in a separate rear extension of the motor cycle sidecar. This has a deep lid containing the transmitter and receiver and a compartment below for the battery. There is also a drop-down flap, convenient to the rider's left hand, which carries a combined telephone-microphone hand set. A loudspeaker is used to warn the patrol when he is being called.

A number of technical problems were encountered when fitting the motor cycle combinations with radio. The customary quarter-wave vertical aerial proved somewhat inefficient owing to its low height and lack of an adequate earth plane, such as the metal roof when a closed vehicle is used. Recourse was made, therefore, to a half-wave vertical aerial with special coupling arrangements at the base as this is a high-impedance point.

Power to operate the mobile equipment also proved a little troublesome. The usual method of fitting a larger accumulator to the existing electrical system and either increasing the dynamo output or fitting a larger dynamo was not applicable in the present case, as during the busy motoring months the road patrols might spend so much time giving road-side assistance to stranded motorists that insufficient running would be done to keep the battery charged.

This problem has been solved by operating the

Left: Radio-equipped A.A. road patrol; note the convenient placing of the hand telephone set. Right: The radio transmitter and receiver are housed in a deep lid on the rear extension of the box sidecar, with the battery in the space below.



radio from a separate battery supply and allotting two large 12-volt batteries (in 6-volt units for ease of handling) to each vehicle and trickle charging the spare battery at night. The normal battery consumption of this receiver is 3 A only.

So far only a limited number of motor cycle patrols have two-way radio telephones and the present scheme is to allot one to each of six zones around London. These are in addition to main-road and special-duty patrols and they have roving commissions within their particular zone, but can be directed to any zone by headquarters should the necessity arise.

Fugitive from Pandemonium

American Television Technician's Reactions to an Abrupt Change

By JOHN D. BURKE

LET me introduce myself. I am an American, whose only knowledge of your country was gained during a few months' service in England with the U.S. Army Signal Corps *en route* to France. Less than a month ago I closed my TV and radio repair shop in New York; now I am working at the same job in London. What are my reactions to that abrupt change?

In all honesty, I can say my first reaction to British TV was to miss about 100 lines of picture. As technicians, we must, of necessity, be highly critical of definition. Does this mean that American 525-line TV is better? No! For the viewer is just as satisfied with 405. Your system has other advantages.

Then I was surprised to see that auto interference causes white flecks, whereas U.S. sets get black interference. Also, I missed the black-faced tubes which are widely used in the U.S. But it was pleasant to find less hum on 50-c/s sets than on 60 c/s. I sought the reason and learned that you use more smoothing.

Where was the band-switch? Then I learned about your five frequencies, and understand how they are being used. My reaction: what a pleasure to be free of noisy band-switches, defective tuner units, irate customers who expect perfect reception on seven channels! And what a relief it is not to have to deal with u.h.f., for which band tuners are first sold to the public and then later perfected.

Your TRF television sets were quite a surprise, as was the absence of the inter-carrier method of sound reception. This method, originally introduced for economy of manufacture, is now generally used in the U.S., even in high-priced sets, because it permits considerable oscillator drift without loss of sound. This problem becomes acute now with the necessity to design all v.h.f. receivers so as to work with u.h.f. converters, which drift badly. At the same time, I am glad to get rid of the problem of intercarrier buzz—a frequent result of overmodulation on TV commercials.

Having heard so much of the economic difficulties of life in post-war Britain, I was surprised that you do not use rebuilt picture tubes. However, with your tax problems it may be there is little justification for rebuilding tubes if they must sell almost at new tube prices.

I miss—and am glad to miss—some of the factors in the American TV scene which are driving radio people in the U.S. quite mad. I have in mind such things as price cutting on TV sets; advertised dirt-cheap service calls; "Fix-it" books which assure the public that repairs are very easy—all repairmen are thieves.

Vertical, instead of horizontal, antennas still look strange to me. It is, of course, an advantage that directional aerials are not needed in strong signal areas, and I shall get used to coaxial cable instead of 300-ohm line.

While you do have many makes and models to service, I have come from a country where over 80 manufacturers have produced over 5,000 models already. Enough said! But I have a feeling that your manufacturers are more responsible in trying to assure that their sets continue to give service. As a repairman, this is a relief to me, for the public tend to blame us for manufacturers' irresponsibility.

Your manufacturers may be right in restricting the distribution of technical and service data on their sets; I simply record my surprise. Perhaps it is because there are so few independent service businesses, as compared with U.S.A.

I am almost overwhelmed by the hundreds of European and British valves I must now learn, besides their bases and sockets. I am in process of learning, too, a different technical language and must master different styles of circuit diagrams.

I cannot end without touching on the programmes—even when writing for a technical journal. I personally am "fed-up" with commercial TV. My countrymen are going mad with as many as seven stations simultaneously transmitting completely different TV programmes. Some of these operate from 7 a.m. continuously till midnight and sometimes till 2 a.m. People sit endlessly before their sets, select what pleases them and do practically nothing else.

As for the B.B.C.'s programmes, from what I have seen I should say that what you are getting is quite similar to what a discriminating viewer would seek, and sometimes find, by switching from channel to channel in the U.S.

In one respect you excel—the production of plays without advertising interruptions and in their entirety. However, I did find "Down You Go!" lacking some of the wit and spontaneity of its American counterpart.

British viewers influence the B.B.C., whereas the sponsors determine what appears on American TV screens. Well-liked programmes simply disappear without a trace due to "sponsor trouble."

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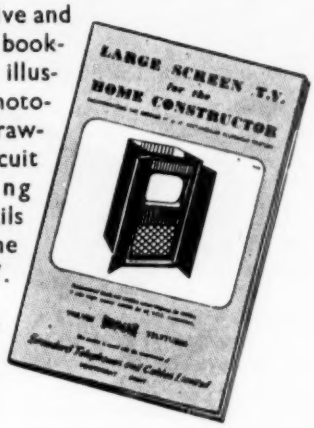

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Ionosphere Review: 1952

Continuing Decrease in Sunspot Activity and Maximum Usable Frequencies

By T. W. BENNINGTON*

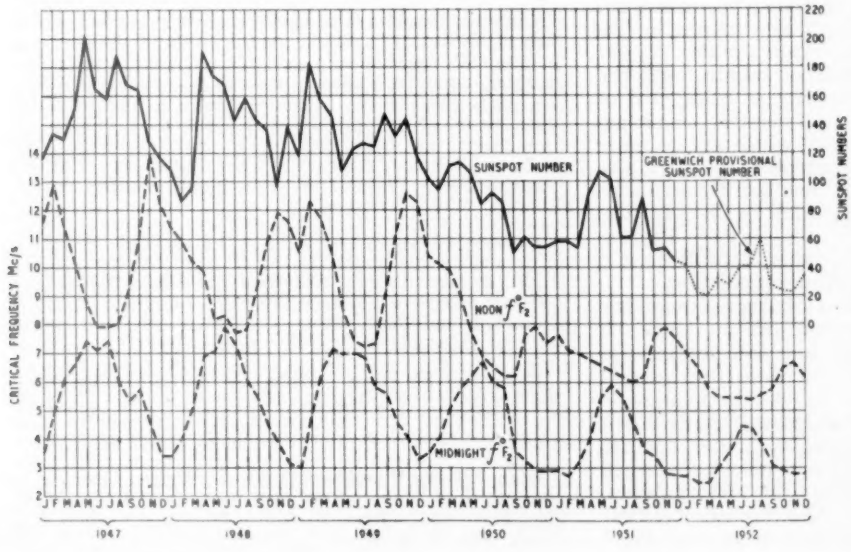
AT the end of 1951 the average sunspot activity was only slightly lower than at the end of the previous year: there had been, during 1951, an arrestment in the previous sharply decreasing tendency. The average critical frequencies of the ionospheric layers, and the maximum usable frequencies for long-distance short-wave propagation had, similarly, undergone but a small decrease throughout the year. During the early part of 1952 the sunspot activity reached generally lower values than it had during the previous year, and the average sunspot activity showed a further considerable decrease during the year. The average critical frequencies and m.u.fs also decreased. In short, the sunspot cycle continued its course towards the minimum, and, at the end of 1952, low values of sunspot number, critical frequency and m.u.f. had been reached.

Fig. 1 shows (a) the monthly mean value of the sunspot relative number for each month since the last sunspot maximum, (b) the monthly mean of the noon F_2 layer critical frequency, and (c) the monthly mean of the midnight F_2 layer critical frequency, the last two curves being from the measurements made at the Slough station of the D.S.I.R.

The sunspot number, which fluctuates greatly from month to month, has now, it is seen, an average value which is very low compared with those which prevailed around the maximum in 1947. The fluctuations in the other two curves are those due to the seasonal effects; there being every year a pronounced minimum in the day-time critical frequency around midsummer, and in the night-time critical frequency around midwinter. However, the long-period decrease due to the decreasing solar activity is also apparent in both the curves, and it is seen that during 1952 the critical frequencies, both for noon and midnight, have been considerably lower on the whole than during 1951. They are now, in fact, at what might be called "quasi-minimum" values. This means, of course, that the m.u.fs for long-distance short-wave communication—which are directly related to the critical frequencies—are also very low at the present time.

Fig. 2 gives the 12-month running means of the sunspot numbers and Slough critical frequencies for the same period as in Fig. 1 By taking 12-month running averages the fluctuations in the curves of Fig. 1 are smoothed out, and it is possible to see the long-period tendencies more clearly. Up to the epoch June/July 1952 (for which the 12-month running mean is the mean for the months January to December 1952 inclusive) the sunspot number had fallen from the values of the order of 150 which prevailed at the solar maximum to a value of about 30. During the same period the mean noon critical frequency had fallen from about 10 Mc/s to about 6 Mc/s, and that for midnight from about 5.7 Mc/s to about 3.2 Mc/s. This implies that the mean noon m.u.f. for transmission over the longest possible one-hop trajectory, with the ionosphere over Slough as its apex, had decreased since sunspot maximum by about 12 Mc/s, and that for midnight by about 7 Mc/s. This gives us some idea of the large variation in m.u.fs which occur over a sunspot cycle, and it must be remembered that the variation in some parts of the world may have been even greater than that for Slough. It will be noticed, however, that the largest decreases in sunspot number and in critical frequency occurred during 1949 and 1950, and that since then there has been a

Fig. 1. Monthly mean sunspot numbers and noon and midnight F_2 critical frequencies since the last sunspot maximum.


SUNSPOT NUMBER
GREENWICH PROVISIONAL SUNSPOT NUMBER
NOON $f^{\circ}F_2$
MIDNIGHT $f^{\circ}F_2$
CRITICAL FREQUENCY Mc/s
SUNSPOT NUMBERS
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1947
1948
1949
1950
1951
1952

* Engineering Division, B.B.C.

Fig. 2. Twelve-month running averages of sunspot numbers and noon and midnight F_2 critical frequencies since the last sunspot maximum, with possible future values of sunspot number.

distinct tendency for the curves to flatten out. This, indeed, is a usual feature during the years preceding the sunspot minimum, and is likely to be even more pronounced in the immediate future. This brings us naturally to a rather important question. What further decreases in the sunspot number are there likely to be, and when will the epoch of minimum activity be reached?

This, however, is a question which it is impossible to answer with any degree of certainty, for the law which governs the variation in sunspot activity, if law there be, is as yet unknown. The sunspot cycles vary very considerably, both in their amplitude and in their duration, and one cannot be very certain of anything about them. However, a close study of the past cycles back to 1750 (for which period relatively continuous records are available) enables certain features to be observed about the cycles, permitting them to be classified into types and classes. According to such a classification (one made by the present writer) the present cycle belongs to the type with high maximum and medium-long duration. By matching it to a "representative" cycle of this type—which is the mean of all the previous cycles of that type—one might hope to obtain some information relevant to the question which we have just asked. The dotted-line end of the curve in Fig. 2 gives the answer as obtained in this way, indicating the possible future values of the 12-month running average sunspot number and the epoch of minimum sunspot activity as being that of November/December 1954. Of course, such an empirical method can give results which are no more than a rough guide (though theoretical methods give results which are no better), and so it should be remembered that the dotted-line curve in Fig. 2 is given as having a "probability" value only. Because insufficient data regarding past cycles is available it is not possible to give a more authentic prediction.

What, then, are the variations of critical frequency and m.u.f. likely to be during the present year? It would seem from Fig. 2 that they will continue to decrease but that this further decrease from present values will be a very small one: in fact, the mean noon critical frequency is likely to decrease by only about 1 Mc/s between now and sunspot minimum. So far as m.u.fs for short-wave communication are concerned they are not likely to vary greatly from present values, albeit tending to decrease. The higher day-time broadcasting frequencies at present in use—21 Mc/s and 17 Mc/s—may become of somewhat decreased utility, and those for the summer night may become somewhat lower—9 Mc/s replacing 11 Mc/s in some cases. As to the winter night, already only the lowest broadcasting frequencies—7 Mc/s and 6 Mc/s—are generally of use at that time, and it is already apparent that a lower frequency than any now available for transatlantic broadcasting would greatly assist in maintaining winter night service.

Some further indications as to the time of occurrence of the sunspot minimum are likely to be provided by the sun itself before that event actually takes place. For there are certain observable features about the sunspots—such as a change in the solar latitudes in which they occur and a reversal in their magnetic polarity—which take place as the minimum approaches and usually about a year before it happens. None of these phenomena has so far been reported by the astronomers as having been observed in association with the presently approaching minimum.

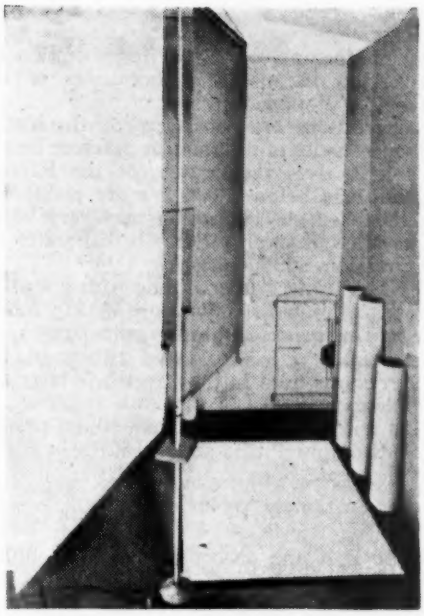
BOOKS RECEIVED

Data and Circuits of Modern Receiving and Amplifying Valves. Book IIIA, Supplement 2, by N. S. Markus and J. Otte. Description and design data relating to Philips receiver, amplifier and rectifier valves introduced during the years 1945-1950. Includes Rimlock, Miniwatt and some Noval types, and also a description of Philips test and measuring equipment. Pp. 487+xi; Figs. 505. Philips Technical Library. Distributed in U.K. by Cleaver-Hume Press, Ltd., 42a, South Audley Street, London, W.1. Price 40s.

Storage Tubes, by M. Knoll and B. Kazan. A survey of principles and a description of types of charge—controlled storage tubes for television and computing devices, with an extensive bibliography Pp. 143+xiii; Figs. 34. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 24s.

Radio and TV Hints. Edited by Martin Clifford. Test and workshop wrinkles for servicemen and amateurs. Pp. 112; Figs. 125. Gernsback Publications, 25, West Broadway, New York 7, N.Y., U.S.A. Price $1.

High Fidelity Simplified by H. D. Weiler. Review of current "hi-fi" equipment and ideas in America. Pp. 208; Figs. 104. John F. Rider, Publisher, 480, Canal Street, New York 13, N.Y. Price $2.50.



Reverberation chamber at Riverbank Acoustic Laboratories, showing rotating vanes and dispersing pillars.

Loudspeaker Efficiency

Technique of Measurement Using a Reverberation Chamber

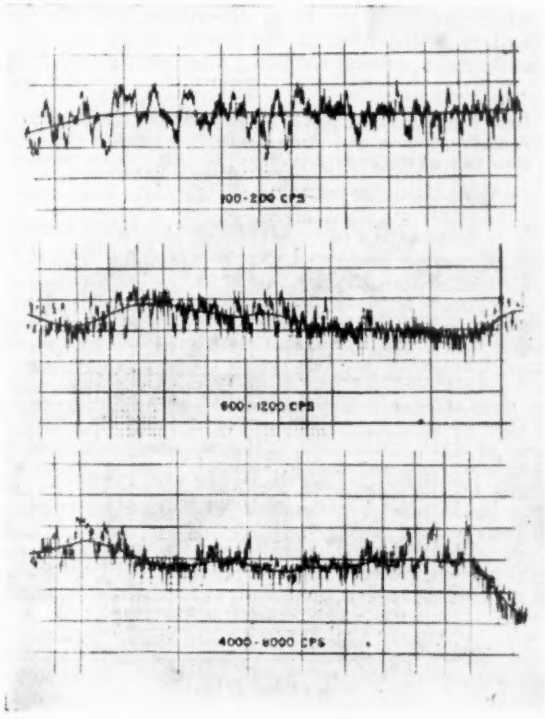
MOST figures for loudspeaker efficiency are derived by calculation from free-field measurements of the sound pressure at selected points, on and off the axis. It is customary to undertake this work only where the radiation from the loudspeaker and its enclosure has an axis of symmetry, and even with this simplification, at least 18 measurements are usual for each chosen frequency. When the output is asymmetrical the integration becomes prohibitively laborious. There are also difficulties in making accurate measurements at the low levels off the axis which are experienced when the microphone is at a sufficient distance from the source to ensure that normal spherical propogation is established.

Echo-free rooms of sufficient size to satisfy this condition would be very expensive as the method of sound absorption must be thorough if it is to give satisfactory results at very low frequencies.

Given ideal conditions of measurement there still remains the problem of how to integrate the results. Most of the power output it radiated not along the axis but at angles of 40 to 60 degrees from it at low frequencies, and at smaller angles at high frequencies. At the angle of maximum radiation, diffraction effects may be marked and they result in a jagged response curve which considerably enhances the difficulties of carrying out an effective integration.

A reverberation method which not only simplifies procedure, but is more closely related to conditions of use is described in a recent issue of the Transactions of the I.R.E. Professional Group on Audio.[1] The sound energy in a room builds up until the power supplied by the loudspeaker is in equilibrium with the absorption losses consequent on reflection from the walls and furnishings at low and medium frequencies and on molecular absorption by the air itself at high frequencies, and in a small room the reverberant sound may exceed the direct sound from the loudspeaker at a distance of 5ft. In an ordinary room, due to eigentone resonances and other causes, the sound distribution is not uniform, and a single measurement of sound pressure would not necessarily indicate the average. Random distribution can, however, be induced by the use of a "warble" tone source, in which the frequency is varied by a few cycles per second about the mean, by cylindrical dispersing surfaces and by rotating vanes which continuously break up standing vibration modes. Such devices are normally employed in reverberation rooms designed for the measurement of absorption in building materials, and the accompany-

Fig. 1. Sections of typical record taken in the reverberation chamber, with average curve superimposed.



[1] "Direct Measurement of the Efficiency of Loudspeakers by Use of a Reverberation Room" by H. C Hardy, H. H. Hall and L. G. Ramer *Trans. I.R.E., P.G.A.*, Nov-Dec. 1952.

ing photograph shows the reverberation room at the Riverbank Acoustical Laboratories of the Armour Research Foundation.

Corrections are necessary for the total absorption characteristics of the room at different frequencies, and Table 1 gives the figures for the Riverbank room. Conditions below 1,000 c/s are stable, but at high frequencies the absorption may vary with humidity. The microphone must also be calibrated or corrected for random sound pick-up.

When using a microphone with a small active surface, the random calibration usually follows the 90-degree incidence calibration up to 3,000 c/s and is only 1 db higher at 5,000 c/s and 2 db at 10,000 c/s. The microphone used in the Riverbank tests was a 640AA condenser type.

In terms of the reverberant sound pressure p_{rev} the power output P of a sound source in a room is given by the expression:

$$P = \frac{p^2_{rev}\ a}{4\rho c \times 10^7} \text{ watts}$$

where a is the absorption in c.g.s. units, ρ is the density of the air and c the velocity of sound.

In decibels above 1mW the power level becomes

$$L_{rev} + 10 \log a - 106.5$$

where L_{rev} is the pressure level in db referred to 0.0002 dyne/cm² and a is the absorption in sabins.

Loudspeaker and microphone are spaced widely apart—usually in different corners of the room—and the loudspeaker is energized under "constant available power" conditions from a "warble" tone generator which sweeps the frequency range of 20 to 10,000 c/s in 40 minutes. During this time the vanes make 40 half-revolutions. The output from the microphone is applied to a graphic level recorder, and typical sections of the record are shown in Fig. 1. Minor fluctuations, of the order of 5db at low frequencies and 2db at high, are averaged and the final curve can be relied upon to 1db.

Corrections are applied for the microphone characteristic and the room absorption, and the final result is of the form of the lower curves of Figs. 2 and 3, the upper curves being the free field response of the same loudspeakers taken on the axis at a distance of 10ft.

From the power output curves and the known input to the loudspeaker the electro-acoustic efficiency can be calculated and the results are given in Table 2. That the figures are lower than those often quoted is attributed by the authors of the original paper to the fact that the axial response usually forms the basis of calculation and that this ignores the directivity factor which is of the order of 6db. Power outputs computed from free-field response measurements at a number of positions round the loudspeaker are shown by circular points.

Not everyone has access to a properly designed reverberation chamber, but it is pointed out by the authors that if a loudspeaker calibrated under ideal conditions is available, useful results can be obtained, using this as a sub-standard, in any large empty room with an ordinary noise level meter and a "warble" tone generator.

TABLE 1.

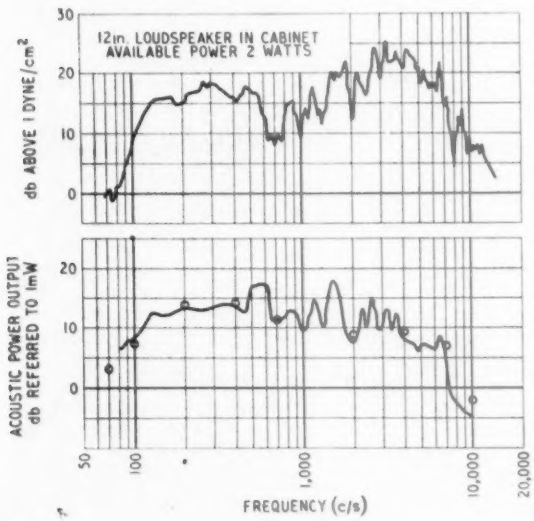
Frequency (c/s)	125	250	500	1,000	2,000	4,000	8,000
Absorption (sabins)	97	96	99	101	116	160	250

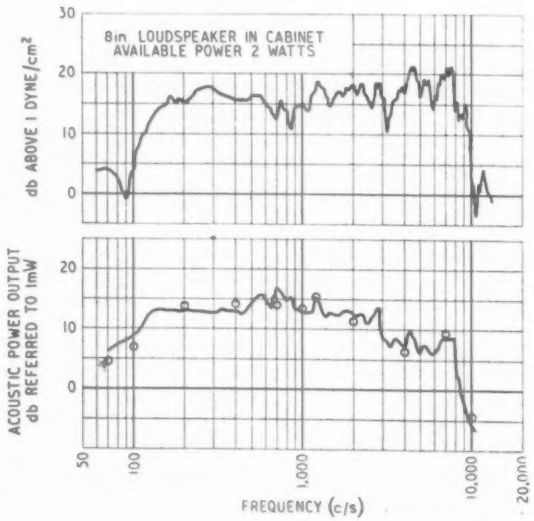
TABLE 2.

Frequency (c/s)	EFFICIENCY (Per cent) 12-in Speaker	8-in Speaker
70	0.1	0.1
100	0.4	0.5
200	1.1	1.1
400	1.1	1.1
700	0.7	2.2*
1,000	0.5	1.0
2,000	0.3	0.6
4,000	0.3	0.3
7,000	0.1	0.4
10,000	0.02	0.01

* Resonant peak.

Left: Fig. 2 (a) Free-field pressure response on axis at 10ft of 12-in speaker in closed cabinet 32in x 32in x 16in deep. (b) Acoustic power output measured by reverberation room method. Right: Fig. 3 Curves of 8in speaker taken under the same conditions as those of Fig. 2.-





LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Television Modulation

YOUR article on low-level modulation (December issue) brings out many, but naturally by no means all, of those factors which must be taken into account in deciding the design of a television transmitter. It is not possible in a letter to touch on all the more important points, but I think that one or two of the points made in the article could perhaps be misinterpreted, and it is on these that I would like to comment.

While in sound broadcasting there are many fundamentally different systems of modulation, in television all transmitters so far constructed have used the same system of modulation, namely, grid modulation, and the difference between various designs resides in the level at which the modulating voltage is applied. It would be technically possible to add amplifier stages at the output of any transmitter so far constructed.

It is true that the transmitter unit itself is bigger in the high-power than in the low-power modulated case. But the difference is only some 100 square feet, and this is small in comparison with the overall size of a transmitter building. If, however, the size of the transmitter is appropriately reflected in its initial cost, then this can be a most important factor.

The power consumption of the transmitter is undoubtedly of the greatest interest, but only in the condition under which the station is normally operated. Full carrier condition on peak white does not represent such a condition, and the power consumption of a television transmitter should be related to the average light intensity of the picture, which is very considerably less than peak white. It is in this condition that the power consumption is of importance.

The difference in power consumption between two typical transmitters operating with a peak-white power of 50 kW, under Test Card C conditions, is relatively small. The advantage, of course, is with the low-power modulation system, but this in itself is not sufficient to be decisive, and it was not in fact the main reason why low-level modulation was adopted for the last two transmitters ordered.

On overall circuit complexity there is not much to choose between the two types of transmitter; the simplicity of the low-power modulator being offset by the complexity in the broad-band r.f. amplifier circuits and by the additional precautions to be taken in the clamping circuits. The design of television transmitters is still fluid, and it is to be expected that many of the developments that have occurred in sound transmitter design will also occur in television equipments. These may be in the direction of parallel operation in order to obtain greater reliability or possibly unattended operation, and higher output powers than have yet been used. The choice of the modulating level, and indeed of the modulating system, has to be considered with all these factors in mind, and it is, I think, too early to draw any firm conclusions as to the relative merits of high- and low-level modulating systems.

London, W.1. F. C McLEAN,
Deputy Chief Engineer, B.B.C.

YOUR article on low-level modulation in the December issue of *Wireless World* contains certain statements which seem to be based on inaccurate information.

Taking first the question of the relative floor space occupied by high-level and low-level modulation transmitters, if one compares the transmitter at Holme Moss with those at Wenvoe and Kirk o' Shotts, one should take into consideration that 40 per cent of the floor area of Holme Moss is occupied by low-tension switchgear.

While you are correct in stating that the modulator of a high-power modulation transmitter is larger than that used on the low-power system, nevertheless I feel that you have based your statement on an out-of-date design. The modulator of the Holme Moss transmitter is a small unit and occupies a very small area. I think it is safe to claim that from the practical engineering point of view there is no difference in the space occupied by transmitters of either type.

With regard to power consumption I note that in your remarks you have coupled the Sutton Coldfield and Holme Moss transmitters. I have no information as to the power consumption of the former, but with regard to Holme Moss, since the design of the power amplifying stages are similar to those of the later low-power modulated transmitters at Kirk o' Shotts and Wenvoe, in the absence of specific figures it is reasonable to assume that the only difference in power consumption is due to the additional power taken by the high-power modulator. In the case of Holme Moss this is only 30 kW, and this figure is difficult to reconcile with your statement.

The comparison of the power consumption of these two types of transmitter at peak-white level is misleading because transmitters are never operated in this condition for any length of time except for test purposes. In any case, I would suggest that power consumption is not the most important criterion; the desirable characteristics of a television transmitter can be written in this order:

1. Adequate performance consistent with the highest reliability.
2. Ease and constancy of adjustment.
3. Power conversion efficiency.

In conclusion, I should like to point out that the cost of the additional 30 kW of power consumed by the Holme Moss transmitter amounts to one or two shillings per hour and is infinitesimal compared with the cost of running the television service as a whole.

Writtle, Essex. E. GREEN.

Editorial footnote.—Statements in the article referred to on the relative sizes and efficiencies of the low-level and high-level modulation transmitters were based partly on information from an I.E.E. Paper "Television Broadcasting Stations" by P. A. T. Bevan, of the B.B.C. In a list of advantages of the low-level system the author put first the smaller size and lower intial cost and second the greater efficiency and reduction in running costs.

We agree that the peak-white criterion, mentioned by both our correspondents, is somewhat unreal, but, nevertheless, it is widely used as a measure of efficiency by transmitter engineers.

Directional Reception

I WAS interested in G. Bramslev's article in the November issue of the *Wireless World*, which described a small tuned loop for long-wave broadcast reception. I have found that a loop aerial can effectively reduce interference due to harmonics from the time-base circuits of television receivers, as well as electrical interference from motors, switches etc. As this action does not involve the directional properties of the loop, the orientation may, in suitable cases, be adjusted to reduce interference from a continental station as well.

A simple arrangement which I have found to work quite well on both medium and long waves consists of a single loop of plain wire round one wall of a living room. By using fine wire (e.g., 36 s.w.g.) and running it along suitable woodwork such as picture rails, skirting boards, door frames, etc., it is possible to make it practically invisible, particularly if painted over at a later date. The advantage of a large loop is that enough signal may generally be obtained without individual tuning for each station. Being unbalanced and unscreened, it will not be a perfect loop, but a rough calculation shows that the fraction of the

output voltage arising from "vertical" pick-up is only about 1/25th at 200 kc/s and 1/5th at 1 Mc/s, if the dimensions of the loop are about 7ft by 10ft.

The ends of the loop are arranged at a convenient point round the wall, and a short length of twin flex is run from there to the receiver. Direct connection to the "aerial" and "earth" terminals gives quite good results if a suitable fixed condenser (usually about 1,000 pF) is placed in parallel with the loop. If whistles due to poor second-channel rejection are encountered other methods of coupling may be tried in order to reduce loading or "pulling" of the input circuit of the receiver.

The plane of the loop is chosen if possible so that any principal station to be received lies in a direction less than 45 degrees from the plane of the loop. A loop may perhaps be bent round the corner of a room so that its vertical sides lie in a plane at right angles to the direction of an interfering station. The usual connection of the earth terminal of the set to earth may be left; the presence or absence of an earth connection appears to have little effect on the loop performance.

An aerial along these lines may appeal to some readers as a basis for experiment if they are troubled by interference either from some local source or from the continent. It should be mentioned that, on stations subject to slight fading, an improved signal-to-noise ratio may also be obtained at the expense of more severe fading. A good outdoor aerial and a good earth form the soundest proposition in such cases. A switch can always be used to select the type of aerial which gives the best results on any particular station.

London, S.W.16. G. J. PHILLIPS.

I HAVE recently used loop aerials to reduce fading and distortion caused by synchronized transmissions; the Ayrshire coast is recognized as a "mush area." Encouraging results have been obtained on 647 kc/s. (Third Programme) where it is required to accept the ground-wave from the low-powered transmitter at Glasgow while rejecting a sky-wave of about the same strength from Daventry. Rejection of the sky-wave is improved by inclining the plane of the loop at about 30 deg to the vertical. Reception of the Home Service (809 kc/s.), which is often spoiled by whistles and by fading, has also been improved.

The loops are auto-transformer coupled to lengths of lighting flex which serve as feeders, the connection to the receiver being made through a small transformer. A loop about four feet square has about the same sensitivity as a short indoor aerial of the conventional sort.

The improvement to be obtained, of course, depends upon the disposition of the transmitters; nevertheless these results show that it is worth while considering the directional properties of loops as well as the noise-rejecting properties stressed by Mr. Bramsley as aids in overcoming present reception difficulties.

West Kilbridge, Ayrshire. R. A. W. HILL.

Drying-out Transformers

J. MACINTOSH'S article (December issue) has prompted me to make some observations on the subject, based on experiences whilst serving in the R.A.F. in Bombay during the war.

The main power transformers of certain radar equipment were found to break down soon after the equipment was put on test after receipt from U.K. Failure was generally found to be due to insulation breakdown between windings, rather than from primary to core; and this was certainly the case with those transformers which had the filament winding of a 4-kV e.h.t. rectifier wound adjoining l.t. windings. This failure-liability was removed by disconnecting the rectifier from this winding and connecting it to a new winding which was added on the outside of the e.h.t. bobbin ("window space" permitted this).

All the main transformers of this equipment were removed on receipt and subjected to a "drying-out." For this they were placed on top of two 1,250-watt flat heaters, which were connected in series so that each received only a quarter of its nominal power. No cover was used, so that moisture could be carried away by the warm air. This was followed by soaking in a beeswax/resin mixture, and, when cool, by "flash-dipping" in a compound of asphalt and other substances.

While some aspects of the this treatment may be criticized by transformer designers, records showed that the reliability of transformers so treated was increased very considerably, even when some time elapsed before they were put into regular service.

Other factors found liable to lead to the breakdown of tropically operated transformers were:

(a) Winding layers filling the space between, and therefore touching, the "cheeks" of a bobbin. Condensation on the "cheeks" encourages shorts between layers. Cheeks are undesirable.

(b) Use of certain types of impregnated cloth for inter-winding insulation. Such "tapes" appear to react with the enamel on the wire; probably the effect is akin to the acidity of bitumen compounds.

Stroud, Glos. T. H. HILL.

V.H.F. as an "Extra"

THE letter published in your issue of December, 1952, is based on what I believe to be a common misunderstanding about v.h.f. broadcasting. The principal reason for introducing v.h.f. in Europe is simply that the medium broadcast band is inadequate to meet the demands now required of it; sooner or later new channels will have to be found. To justify the expenditure involved, the service must eventually be capable of an appeal far wider than that envisaged by your correspondent; to establish it merely as an "extra" would be indefensible for the reasons given in his letter.

The Germans have been obliged to base their broadcasting on v.h.f. as described in your April, 1952, issue. A further study of the German service would be a far more useful guide to the value of v.h.f. broadcasting than reports from America which, however excellent in themselves, often have no relevance to broadcasting conditions in Europe.

Newbury, Berks. D. R. A. MELLIS.

Future of Broadcasting

YOUR correspondent, L. Streatfield (January issue) says, "Interference from other transmitters is a question of set design." How I wish he lived in East Anglia and had struggled for two years to receive the B.B.C. on medium waves with reasonable entertainment value. Perhaps he could then tell me how to eliminate a 1-kc/s heterodyne from an adjacent carrier without seriously impairing quality. An AR88 communications receiver will not give interference- and fading-free reproduction of any B.B.C. regional programme here (during the hours of darkness). Neither is an audio filter with a 1-kc/s cut off conducive to good quality.

Others must feel, as I do (paying the licence fee and living outside the television service area), that a little of the B.B.C.'s attention might be diverted from television to giving a country-wide sound service.

Apathy in places outside the real service areas probably arises from ignorance. The inhabitants may imagine that Londoners, etc., sit huddled around their receivers trying to catch a word here and there, while, throughout, their eardrums are assailed by a deafening whistle.

I, for one, would welcome a local v.h.f. transmitter.

Ipswich. H. S. KING (G3ASE).

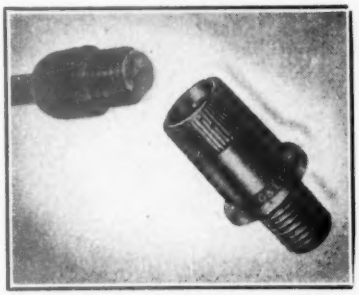
THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Meet the "Sparkmaster"

As nobody seems to want his car "suppressed," we are going to sell our distributor suppressor and sparking plug suppressor under the names "Sparkmaster" and "Sparkmaster de luxe" respectively. There is no doubt that the desirability of suppressing ignition interference in motor cars has stimulated research into what happens when so doing, and that the industry has learnt that there are several benefits, and so far nothing detrimental in fitting resistors in the ignition circuit.

For example, the resulting spark is less violent but its useful period is prolonged. There would appear to be smoother combustion, with a tendency to reduce plug erosion. Then there is the fairly well known United States army report on the greater ease of cold starting. We do know that one of our biggest motor manufacturer customers interested in expensive high performance cars, fits resistors as part of the electrical design, and not as suppressors. It is all very interesting, but still the public is doubtful.

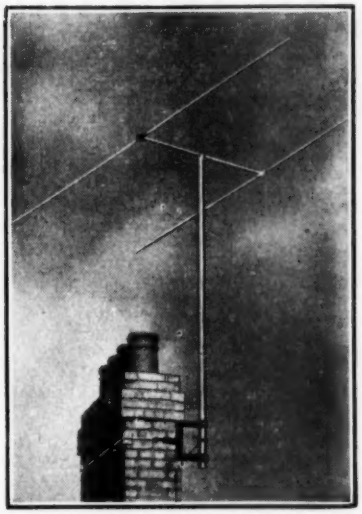


"Belling-Lee" "Sparkmaster".

If the public won't fit resistors, perhaps they can be coaxed into so doing with advantage to themselves and viewers. The writer drives a "Velox" with a "Sparkmaster de luxe" at each plug and a "Sparkmaster" at the distributor, and believes the car goes better that way. Certainly nothing detrimental has been noticed while driving a ¼ million miles.

An Interesting Thought

Will there be horizontal aerials in Wigtownshire? It is the shortest crossing from Britain to Ireland—36 miles. From Belfast to Stranraer is just about 45 miles, practically all across sea. Kirk o' Shotts to Stranraer is about 80 miles all across land. Other towns that might be affected are Wigtown, Kirkcudbright, Newton Stewart, Glenluce. Our guess is that there is every possibility that reception



A "Belling-Lee" horizontally polarised television aerial.

of television from Belfast may be better than from the Scottish Station, particularly when Belfast goes to 5 K.w.

Can you beat it?

Some months ago a customer purchased one of our flex lead suppressors, the L.301, to suppress a hair dryer which caused interference with a neighbour's television receiver. In spite of the fact that each L.301 suppressor is supplied in a carton bearing the warning "ineffective at television frequencies," the suppressor was fitted, and the interference disappeared completely.

All went well until recently, when the receiver was changed for one of a different manufacture; at this juncture the interference returned and could not be overcome by any amount of experiment with the suppressor—quite a problem but not without a simple explanation.

The L.301 is effective up to approximately 20 Mc/s, and therefore suppressed interference which

Flex lead suppressors, top L.301, lower L.1174.

was being picked up by the 10 Mc/s I.F. stages of the original receiver, and not, most fortunately, by the aerial or first stages of amplification at the frequency of the television transmission. The second receiver, which was tunable, possessed tunable I.F. stages of approximately 30 Mc/s, and interference radiated by the hair dryer made itself only too evident.

For the suppression of interference at television frequencies, some form of filter network must be fitted within the case frame of the offending appliance, and since space and airflow within such appliances as hair dryers involves mechanical rather than electrical consideration, suppression in many cases may not be practicable.

At normal broadcast frequencies, interference may be suppressed satisfactorily by our L.301, but at television frequencies the majority of interference is radiated directly from the offending appliance.

The Coronation

There is no doubt that the Coronation will be a terrific boost to television. Many hundreds—nay, thousands of people—will decide that they must have a receiver in time.

We have said it before, and will probably say it many times again, a pantechnicon full of television receivers may pull into a town, and they may all be delivered that day, but it would take some days, depending upon the weather and the time of the year, to erect all the aerials. Every firm doing aerial installations is going to be up to its eyes in work until the Coronation is over. The better qualified and better known they are, the busier they will be.

We know, as sure as we are writing this page, that friends will ring us up "in plenty of time"—a month or so to go—to ask us to do "that special job" that we would dearly like to do. For example to install a television system for a visiting dignitary, or to equip a hall with a number of receivers to show the Coronation to the very old and the very young. Such a lot of that kind of work will come along, and we do like the unusual and the difficult. Please help us to help you, and please do not expect the impossible.

Written 30th December, 1952.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND

40 MARCONI RADIO BEACONS

will ring the British Isles

From the Channel Islands to the Shetlands, from the Thames to the West Coast of Ireland . . . 40 lighthouses and lightships around the coasts of Great Britain and Ireland are to be equipped with Marconi Marine Beacons by the Lighthouse Authorities. These M.F. Beacons will be fully duplicated with changeover switching, indicating and alarm facilities; in addition specially selected stations in the vicinity of the main ports will provide 'request' transmissions.

MARCONI marine beacons

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD · CHELMSFORD · ESSEX

WORLD OF WIRELESS

Fringe-area Television Repeater ◆ Components and Instruments Shows ◆ Extending Home Service Coverage ◆ Captain Round Honoured

Television Booster

ALTHOUGH, as reported last month, the Asst. P.M.G. had stated that the Government could not, for the time being, sanction any further television stations, the B.B.C., acting upon an earlier Ministerial statement that the Corporation hoped to be able to improve reception in the Brighton area, is planning to install a booster station in the locality in time for the Coronation. A low-power repeater station, made by Ekco and installed experimentally in Essex, was described in our December issue.

The transmitter for Brighton, if sanctioned by the P.M.G., will operate in Channel 3 (used by Kirk o'Shotts). It has been stated in some published reports that the transmissions will be horizontally polarized, as will those from the temporary stations in Belfast and Newcastle. It is learned, however, from the B.B.C. that as the Stockholm Plan provides for the proposed Isle of Wight station to use vertical polarization, the booster will, if sanctioned, do the same to save viewers from making a change when ultimately the permanent station comes into service.

At the time of going to press, tests are being conducted on Truleigh Hill, north of Shoreham.

Servicemen's Wages

OUR report on page 24 of the last issue on the award of an increase of 15s per week in the minimum rates of pay to servicemen was apparently open to misinterpretation. There should have been no implication that the dispute was taken to arbitration jointly by the Radio and Television Retailers' Association and the Guild of Radio Service Engineers. It was, in fact, G.R.S.E. which reported the dispute to the Minister of Labour and National Service who referred the case to the Industrial Disputes Tribunal.

Two April Shows

AS has happened during the last two or three years, the dates of the Physical Society's exhibition of scientific instruments and apparatus overlap those of the Components Exhibition organized by the Radio and Electronic Component Manufacturers' Federation. The Physical Society show is planned for April 13th-17th and the R.E.C.M.F. show for April 14th-16th.

The Physical Society's thirty-seventh annual exhibition will be held in the Royal College of Science, Imperial Institute Road, South Kensington, and the component show at Grosvenor House, Park Lane, London, W.1.

Tickets for the scientific instruments show, which is open daily from 10 a.m. to 8 p.m. (with the exception of the last day when it closes at 5 p.m.), are available from exhibitors or the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7. Early application should be made for tickets which, as in previous years, are valid for specified days or sessions (mornings 10 a.m. to 1 p.m., evenings 5.30 p.m. to 8 p.m.).

It should be noted that the exhibition is this year confined to the Royal College of Science.

The components show, which will also include test gear, valves and accessories, will be open daily from 10 a.m. until 6 p.m., except on the last day when it will close at 5 p.m. Admission to the show is by invitation ticket, obtainable from the organizers (R.E.C.M.F., 22, Surrey Street, London, W.C.2) and exhibitors, but these are only available to those having a professional, industrial or trade interest in the equipment exhibited.

Armstrong Medallist

CAPTAIN H. J. ROUND, who will be remembered by our older readers as the originator of the Round "soft vacuum" valve and the regenerative self-heterodyne circuit (1913) and for his development of d.f. equipment during the first World War, has been awarded the Armstrong Medal by the Radio Club of America. The award has been made "in recognition of his contributions during half a century to the radio art, and especially of his revolutionary developments during World War I in the fields of direction and position finding and the high amplification of short-wave signals."

CAPT. H. J. ROUND (right) receiving the Armstrong Medal from the president of the Radio Club of America.

Home Service Transmitters

THE temporary caravan transmitter at Fremington, between Barnstaple and Bideford, which has been in service since last March has now been replaced by a permanent station on the same site. It is completely automatic and the two 660-W Marconi transmitters work in parallel. A third unit will be added later to bring the power up to 2 kW. The station operates on 1,052 kc/s.

Caravan transmitters have been brought into service at Towyn, Cardiganshire, on 881 kc/s, and at Mousewald, near Dumfries, on 809 kc/s, where permanent stations are eventually to be built to improve reception of the Home Service. It has also been announced by the B.B.C. that a Home Service transmitter is to be installed at Redruth, Cornwall, where there are already two transmitters radiating the Light and Home Programmes. The 2-kW transmitter will radiate on 1,457 kc/s.

Italian Television

PLANS have been completed by the Italian broadcasting service —Radio Audizione Italiana—for a network of 14 television stations with studios in Rome, Milan and Turin. The first phase in the implementation of the plan is to erect nine transmitters in Northern Italy.

British equipment is being employed for some of the stations which will operate in the 174- to 216-Mc/s band on 625 lines. A £300,000 order has been placed with Marconi's for four cameras and associated studio

equipment at both Rome and Milan (which will, incidentally, be linked by radio), two O.B. vehicles and 7½-kW vision and 2½-kW sound transmitters for Rome and Monte Serra.

In addition to the experimental television stations operating in Turin and Milan and those already mentioned, there will be transmitters at Monte Venda, Monte Penice, Portofino, Florence and Monte Peglia.

PERSONALITIES

Dr. E. F. W. Alexanderson, originator of the r.f. alternator (1909) has, at the age of 74, joined the Radio Corporation of America as a consultant. He joined the General Electric Co. of America in 1902 and, except for a brief period in the early 'twenties, was with that company until his retirement a year ago.

Capt. R. T. Paul, C.B.E., A.M.I.E.E., R.N.(Retd.), has joined Mullard's Equipment Division as commercial manager, co-ordinating the activities of the groups producing radio, telephone and electronic equipment. As Chief Signal and Radio Officer to the Allied Naval C.-in-C., Expeditionary Force, he was responsible for the naval signal, radio and radar organization for the Normandy invasion and was the first chairman of the Western Union Communications Committee (Naval).

Leslie Cooper, the new president of the Radio Society of Great Britain, has been a member of the Society for 23 years and has operated his own station (G5LC) for 22 years. He is also in

LESLIE COOPER

radio and telecommunications professionally as a production engineer. He was for 15 years with E.M.I. and during the war was in charge of ground radar production. Mr. Cooper, who was honorary secretary of the R.S.G.B. in 1951, is also president of the Thames Valley Amateur Radio Transmitters' Society, and is holder of a number of amateur operating certificates.

Major Rowland Shears has been elected the first honorary member of the German Amateur Radio Society in recognition of his services on behalf of amateur transmitters when he was secretary of the Radio Committee of the British Signal Communications Board in Germany. It was largely due to his efforts that German amateurs were granted licences in 1949. Major Shears, who is now a senior development engineer at the Electronics Laboratory, Burndept, Ltd., Erith, operates his own transmitter (G8KW) and whilst in Germany used the call DL4KW.

R. P. Browne, secretary of the Radio Industry Council and its predecessors N.A.R.M.A.T. and R.M.A., has been given leave of absence to enter the

R. P. BROWNE, O.B.E., B.Sc.

London Hospital for an orthopædic operation. During his absence, which we regret to learn is expected to be for some months, **G. B. Campbell,** the deputy secretary, who is normally engaged on the work of the technical committees of the Council, will be acting as secretary.

D. C. Brice has joined the staff of the R.I. Council as temporary assistant to Mr. Campbell, mainly for the technical side of the Council's work. Mr. Brice served in Royal Signals during the war and in 1942-43 was at the G.H.Q. Wireless Station, New Delhi. He was a member of Lord Mountbatten's staff, both during the war and later at Viceregal headquarters.

Edward Cattanes, M.Brit.I.R.E., Assoc.I.E.E., has resigned his position as manager of the Industrial Electronics Department of the English Electric Co., Stafford, which he had held since 1949. He was previously manager of the Electronics Products Division of the Radiotel Corporation (Philco) and of the engineering sales of its subsidiary Airmec Laboratories. From its inception in 1936 to 1947 he was manager of Cossor's Electronic Instruments Division and was responsible for introducing the well-known double-beam oscilloscope. He is a member of the Technical Committee of the Brit.I.R.E. and, until recently, was chairman of the Industrial Electronics Section of the R.C.E.E.A.

N. D. Bryce, sales development manager, **E. A. Taylor,** commercial sales manager, and **A. Cook,** M.B.E., secretary, who have all been with Belling and Lee for over twenty years have been appointed executive directors of the Company.

Alan P. Ross, has joined Thorn Electrical Industries, Ltd., and will be mainly concerned with the sale of special products and components. He was previously with Belling & Lee.

A. G. Coates, M.I.E.E., was recently appointed superintendent of communications, Iraq Petroleum Co., Ltd., which he joined in 1948. He had previously held the positions of deputy engineer-in-chief, Palestine Posts & Telegraphs, and chief engineer, Iraq Posts & Telegraphs.

L. C. Bingham, general sales manager of Venner, Ltd., and Venner Accumulators, Ltd., is on a two-month tour of India and Pakistan.

NEW YEAR HONOURS

B. E. Nicolls, C.V.O., C.B.E., who was, until recently, Director of Home Broadcasting (B.B.C.) and during the interregnum was acting Director-General, is created a knight bachelor.

J. A. Smale, B.Sc., M.I.E.E., engineer-in-chief, Cable and Wireless since 1948, is appointed C.B.E. He joined C. & W. in 1932 and, in addition to development work on long-distance s.w. relay stations for overcoming unfavourable propagation conditions, has been concerned with the development of frequency-shift keying. He is a vice-chairman of the I.E.E. Radio Section.

H. T. Bennett, managing director of the Marconi Telegraph Co. of Egypt, also becomes a C.B.E.

A. A. Dyson, managing director of Eric Resistor, Ltd., is appointed an O.B.E.

R. H. A. Carter, senior experimental officer at T.R.E., Malvern, who was awarded £750 by the Royal Commission on Awards to Inventors for his work on I.F.F., becomes an M.B.E.

G. B. CAMPBELL
(See centre column)

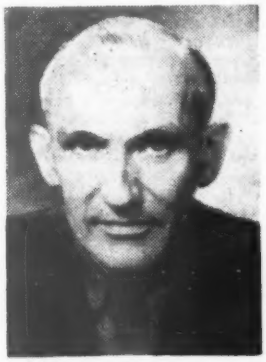
A. H. Farman, chief radio officer of the *Queen Elizabeth*, is also appointed an M.B.E. He has been a sea-going radio officer since 1913 and has served with the International Marine Radio Co. for 21 years. He joined the *Q.E.* as chief radio officer for her secret maiden voyage in 1940.

S. Wort, station officer at the War Office Wireless Station, is also among the new M.B.E.s.

OUR AUTHORS

F. W. O. Bauch, who contributes the article on p. 50, studied physics at Berlin Technical University. In 1930 he became a member of the Heinrich Hertz Institute, where he did research work on supersonics. Then followed a short spell at the G.E.C. Research Laboratories, Wembley, prior to joining the Dutch Philips Co. in Berlin, where he remained for eight years. The latter years of the war were occupied with research on high-frequency pulse technique. After the war, he was appointed chief engineer of the Berlin broadcasting station "RIAS." Returning to this country in 1947, he first

worked at the Electrical Research Association but is now scientific and technical representative of various German research organizations and manufacturers.



F. W. O. BAUCH.

J. F. Hartwright, contributor of the article on television O.B. units, served as a sea-going radio officer before joining the B.B.C. staff at Daventry as a maintenance engineer in 1935. He was transferred to the London television station in 1938 and after the closing of the television service in 1939 stayed at Alexandra Palace working on radio counter-measures. He became senior engineer-in-charge of a television O.B. mobile control room in 1948.

D. F. W. Champion, co-author of the article "Magnetic Powder Cores" in this issue, graduated from London University in electrical engineering in 1948. He joined the Research Laboratories of the General Electric Co. in 1942, where he has worked on the applications of magnetic materials and the development of special test equipment.

E. G. Wilkins, who, with D. F. W. Champion, contributes the article on p. 83, joined the G.E.C. Research Laboratories in 1941. After service in the R.A.F. from 1943-46 he studied at Durham University and graduated B.Sc. in 1948. In the same year he rejoined the G.E.C. and has been working on problems associated with the preparation of magnetic materials.

L. S. Allard, who contributes the article in this issue on a storage tube for digital computing machines (p. 95), graduated from London University (Chelsea Polytechnic) with a B.Sc. degree. He joined the G.E.C. Research Laboratories in 1941 and has worked on cathode-ray tubes, specializing in the design of electron guns and cathode-ray beam devices.

OBITUARY

It is with regret that we announce the death, on December 27th at the age of 53, of **William Thomas Gibson**, O.B.E., M.A., B.Sc., M.I.E.E., chief valve engineer of Standard Telephones and Cables, Ltd., and manager of their Ilminster laboratories and factory. He joined the staff of the Western Electric Co. (later S.T.C.) in 1922 to initiate the manufacture of radio valves. He also set up the valve laboratory of Le Matériel Téléphonique in Paris in 1928, and the Newark, New Jersey, valve laboratory of Federal Telephone Laboratories in 1932.

IN BRIEF

Receiving Licences. — A further 81,000 television receiving licences were issued in November, bringing the total at the end of the month to 1,813,790. There were also 10,860,521 licences current for sound receivers and 170,429 for car radios, making a total of 12,844,740.

Radio Astronomy Research.—One of the two Mackinnon Research Studentships of the Royal Society has been awarded to R. C. Jennison, of Manchester University, to work on radio astronomy at the Jodrell Bank station.

E.P.T.A.—Non-members are welcome at the all-day meeting of the Electro - Physiological Technologists' Association which begins at 10.30 a.m. on February 7th at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5, when papers and demonstrations will be given. Application should be made to the honorary secretary, G. Johnson, Hurstwood Park Hospital, Haywards Heath, Sussex, before February 1st.

Surveying and Charting the Norfolk Broads after an interval of 18 years has recently been undertaken with the aid of a Marconi "Seagraph" recording echometer modified for shallow sounding work. The permanent contour graph of the bed indicates not only the depths—even where there is less than 2ft of water—but also whether the bottom is hard sand, gravel or soft mud.

Patents Exhibition.—Of the 100 "important patent specifications granted during the century in the major industries" which were displayed at the recent Patent Office Centenary Exhibition, a dozen or more related to radio, including Armstrong's super-regenerative circuit (1923), Baird's original television patent (1924) and Watson-Watt's first radar specification (1936).

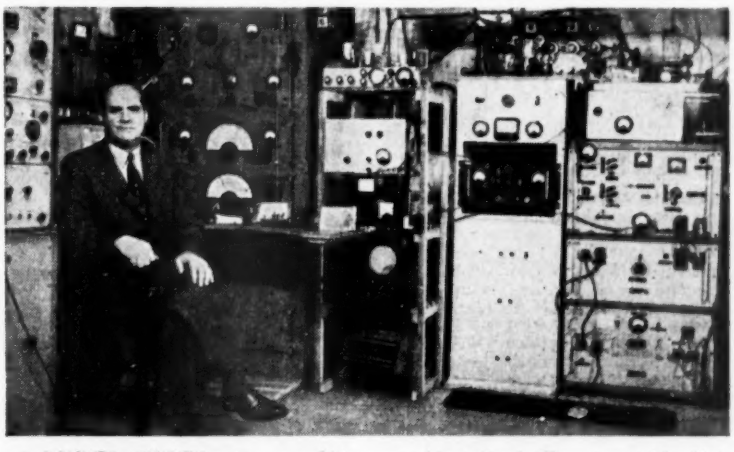
Insulating Materials.—A symposium of papers dealing with the selection and use of dielectrics in electrical engineering has been arranged by the Measurements Section of the I.E.E. and will be held at Savoy Place, London, W.C.2, from March 16th to 18th.

R.S.G.B. Officers.—At the annual general meeting of the Radio Society of Great Britain on December 19th, Leslie Cooper (G5LC) was elected president. The new vice-president is A. O. Milne (G2MI), who is the Society's QSL manager. D. A. Finlay (G3BZG) is honorary treasurer, C. H. L. Edwards, A.M.I.E.E., (G8TL), is honorary secretary and John Hum (G5UM) continues as the honorary editor of the Society's *Bulletin*. The following were elected members of the committee: I. D. Auchterlonie (G6OM); P. W. Winsford (G4DC); R. H. Hammans (G2IG); H. A. Bartlett (G5QA); L. E. Newnham (G6NZ); F. Hicks-Arnold (G6MB); H. McConnell (GM2ACQ).

Higher Technology Courses.—Among the courses listed in the latest Bulletin issued by the Regional Advisory Council for Higher Technological Education are a number covering radio and allied subjects beginning in the next month or two. The courses, listed both alphabetically under colleges at which they are held and by subject, are mostly part-time or short full-time. The Bulletin, which covers some 80 courses in higher technology in colleges in London and the Home Counties, is available (price 1s 6d) from the Secretary, the Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1.

Plastics Exhibition.—The second British Plastics Exhibition, originally arranged by the organizers, *British Plastics*, for the period June 3rd to 13th (before the date of the Coronation was known), has been postponed until June 8th to 18th. The Convention, running concurrently with the Exhibition, and also at Olympia, will cover the most recent developments in plastics technology and applications.

Glass Exhibition.—Although glassware is one of the many "raw materials" used in radio it is certainly at the heart of affairs in a television set. We, therefore, think it worth while drawing readers' attention to the first National Glass Industries Exhibition which will be held in the New Horticultural Hall, Westminster, S.W.1, from May 11th to 16th.



J. BANNER, GW3ZV, with some of his gear at his station in Glamorgan with which he scored the highest European marks in the A.R.R.L. contest, and for the third successive year made the highest score in the British Isles. He uses separate transmitters for each of the six bands from 1.7 to 28 Mc/s and employs a triple-diversity 84-valve receiver.

Projection Television Receivers are to be installed in the Lambeth Town Hall on Coronation Day to enable 2,000 elderly and disabled citizens of the Borough to see the B.B.C. transmission of the procession and ceremony. The forward-projection receivers, providing a 4ft × 3ft picture, are being lent by Decca Radio and Television, whose head office is in the Borough of Lambeth.

F.M. in France.—The experimental 200-watt f.m. transmitter at Paris-Grenelle is to be replaced by a 15-kW transmitter. The station radiates on 99 Mc/s.

PUBLICATIONS

"Radio Designer's Handbook," edited by F. Langford-Smith, which has been out of print for a long time, has now been rewritten and greatly enlarged (1474 pp.). The fourth edition (price 42s) is expected to be available by the end of May. Originating in Australia, it is again being issued in this country by our Publishers, who ask us to advise readers to place their orders early with their booksellers.

Purifying Germanium.—As is known, germanium for use in rectifiers must have a high degree of purity. In order to follow the elimination of arsenic—the most important impurity—the Inorganic Group of the D.S.I.R. Chemical Research Laboratory has developed a radio-active tracer method. An account of this investigation is given in "Chemistry Research, 1951" published by H.M.S.O., price 4s 6d ($1.15 U.S.A.).

Research in Universities.—What is hoped will be an annual publication has recently been issued under the ægis of D.S.I.R.—the title is "Scientific Research in British Universities 1951-2." Details of the research being undertaken in universities and colleges throughout the U.K. include the names of the staff working on the problem and a brief description showing the scope of the research. It is available from H.M.S.O. price 8s ($1.80 U.S.A.).

"ZL" Calls.—The annual call-book number (January, 1953) of *Break-In*, the official organ of the New Zealand Association of Radio Transmitters, gives the addresses of all amateurs in the North and South Islands.

Italian Call Book.—A special number of our Italian contemporary *Radio e Televisione*, published in August, contains a complete list of "I" amateur calls.

BUSINESS NOTES

Marconi Valves.—We are asked to point out that whilst the Marconiphone Valve Department, as announced last month, is now at 3, Stanhope Street, London, N.W.1, Marconi valves or Emiscope c.r.ts returned with claims for replacement should be sent as previously to the Valve Test Division, E.M.I. Sales & Service, Wadsworth Road, Greenford, Middx.

Sobell Industries advise us that their five-valve three-waveband a.c. table receivers, 512W and 553, have been approved by the School Broadcasting Council for use in schools.

International Aeradio has installed synthetic air-traffic control training equipment at the French Civil Aviation School at Orly Airport, Paris.

An English Subsidiary of Phillips Control Corporation, of Joliet, Illinois, to be known as Phillips Control (G.B.), Ltd., is being set up to manufacture solenoid actuators in this country. The company will operate in association with Harvey Electronics, Ltd., of 273, Farnborough Road, Farnborough, Hants, where it is planned to produce initially two types of solenoid—Type 41 with a maximum stroke of ¼in and Type 42 with a maximum stroke of ½in. Both will be available for voltages from 6 to 400 (a.c. or d.c.).

Airmec has dropped the word Laboratories from the name of the company as it is felt that it is misleading and bears no relation to the manufacturing capabilities of the company. The registered name and address is now Airmec, Ltd., High Wycombe, Bucks.

Kits of Parts, including the necessary assembly tools, for the construction of prototype "H" switches are now available from A.B. Metal Products.

Vidor's Bristol distribution depot is now in Cumberland Street, Day's Road, and the company's television service depot is in Day's Road, St. Phillips, Bristol (Tel.: Bristol 58481, Ext. 5). J. Boorman Leonard is the service technician in charge.

Exide and Drydex Depot in Bristol was recently moved from Broadmead to Whitehouse Street on the city's Bedminster industrial estate.

Telecraft, Ltd., manufacturers of aerials and accessories, advise us of changes of address of two of their depots. The Birmingham depot is now at 75, Holyhead Road, Handsworth (Tel.: North 6301, Ext. 2) and the Cardiff depot at 1 & 2, Stuart Street (Tel.: Cardiff 25955).

MEETINGS

Institution of Electrical Engineers

Radio Section.—"A Method of Designing Transistor Trigger Circuits" by Prof. F. C. Williams, O.B.E., D.Sc., D.Phil., F.R.S., and G. B. B. Chaplin, M.Sc., on February 11th.

"Radio Aids for Airport Control" by G. W. Stallibrass, O.B.E., on February 23rd.

Both the above meetings will be held at 5.30 at Savoy Place, London, W.C.2.

"Ignition Interference with Television Reception" by A. H. Ball and W. Nethercot at 5.30 on February 10th. Joint meeting with the Institution of Mechanical Engineers at Storey's Gate, London, S.W.1.

Cambridge Radio Group.—"Electronic Aids for Film-Making" by T. C. MacNamara at 6.0 on February 17th at the Cambridgeshire Technical College.

North-western Radio Group.—"Television Receiver Design" by A. J. Biggs, Ph.D., B.Sc., at 6.30 on February 18th at the Engineers' Club, Albert Square, Manchester.

North Scotland Sub-Centre.—"Topics on the Design and Testing of High-power Valves" by A. M. Hardie, M.A., B.Sc., at 7.30 on February 11th at the Caledonian Hotel, Aberdeen, and at 7.0 on February 12th at the Royal Hotel, Dundee.

South Midland Centre.—Discussion on "The Co-ordination of Technical and Practical Training" at 6.30 on February 20th at the College of Technology, 53, Broad Street, Birmingham. (Joint meeting with the Students' Section.)

Southern Centre.—"Principles of Colour Television" by J. H. Mole, Ph.D., and J. W. R. Griffiths, B.Sc., at 6.30 on February 4th at the Municipal College Extension, Portsmouth. (Joint meeting with the Students' Section.)

"The Technique of Manufacture of Reliable Valves" by E. A. Roberts, Ph.D., M.Sc., at 6.30 on February 25th at the South Dorset Technical College, Weymouth.

Oxford District.—"Colour Television" by G. G. Gouriet at 7.0 on February 11th at the Southern Electricity Board, 37, George Street, Oxford.

Reading District.—"Colour Television" by G. G. Gouriet at 7.0 on February 2nd at the Electricity Demonstration Room, Market Place, Reading.

London Students' Section.—Visits to the G.E.C. Research Laboratories, North Wembley, at 2.15 on February 4th and the E.M.I. Factory, Hayes, at 2.0 on February 18th.

British Institution of Radio Engineers

London Section.—"Modern Trends in Communications Materials" by L. A. Thomas, B.Sc., F.Inst.P., at 6.30 on February 11th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section.—"The Principle of Electronic Computing Machines" by B. V. Bowden, Ph.D. (Ferranti) at 7.0 on February 5th at the Department of Natural Philosophy, The University, Edinburgh.

Merseyside Section.—"A Port Radio-Telephone System" by D. G. Holloway at 7.0 on February 5th at the Electricity Service Centre, Whitechapel, Liverpool.

North Eastern Section.—"Design Considerations of a Commercial F.M. Receiver" by F. H. Beaumont, A.M.Brit.I.R.E., at 6.0 on February 11th at the Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-on-Tyne.

West Midlands Section.—"The Development of the Radio and Electronics Industry in India" by G. D. Clifford, M.Brit.I.R.E., at 7.15 on February 24th at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

British Sound Recording Association

London.—"The Human Ear and Audiometry" by T. S. Littler, M.Sc., Ph.D., at 7.0 on February 20th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Manchester Centre.—"Loudspeakers" by H. Collings-Wells (Goodmans) at 7.30 on February 23rd at the Engineers' Club, Albert Square, Manchester.

Portsmouth Centre.—"Reproduction in the Home" by P. J. Walker at 7.15 on February 12th at the Central Library, Guildhall, Portsmouth.

Television Society

London.—"The Importance of the D.C. Component" by D. C. Birkinshaw, M.B.E. (B.B.C. Television), at 7.0 on February 12th.

"The Scanning Electron Microscope" by D. McMullan, M.A. (Cambridge University), at 7.0 on February 27th.

Both meetings will be held at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Radio Society of Great Britain

"Oscilloscopes" by Frank Hicks-Arnold (G6MB) at 6.30 on February 27th at the I.E.E., Savoy Place, W.C.2.

Simultaneous Translation at N.A.T.O.

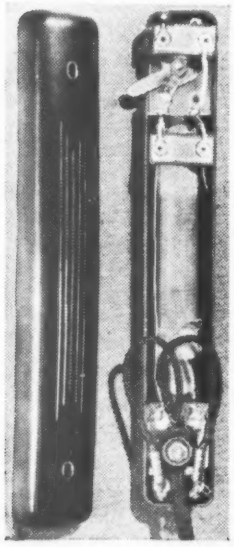
Details of the Westinghouse R.F. Induction System

By E. AISBERG*

The receiver is hung from the pocket, and volume can be varied by inclining it from the vertical.

AT international conferences, where language difficulties might otherwise impede the smooth conduct of affairs, it is customary to employ a system of simultaneous translation. Trained linguists listen to the original speech on headphones and give an immediate translation into a microphone, the output of which is amplified and relayed to headphones connected near each delegate's seat.

This system has proved effective, but has this disadvantage that the delegate is virtually tied to his seat. Recently, portable wireless receivers have been tried, with switched choice of wavelengths carrying translations in different languages, but in spite of recent advances in miniaturization these sets remain relatively cumbersome and heavy because of their battery power supplies. They are also liable to go out of service at inconvenient times.



A Ferroxcube core is used in the inductance, and a simple switch at the top of the unit selects alternative frequencies.

At the last conference of the North Atlantic Treaty Organization at the Palais de Chaillot in Paris a new system was tried which successfully overcomes the drawbacks of its predecessors. This system, which has been developed by F. C. G. van Baerle, of the Compagnie des Freins et Signaux Westinghouse, depends on the establishment of a radio-frequency magnetic field of uniform intensity by means of loops encircling the building. This energy is picked up by a simple form of crystal receiver which requires no batteries and can be carried without inconvenience.

There are two loops fixed at heights of 2 and 4 metres, energized by 4- to 5-watt modulated oscillators, one for French with a carrier of 300 kc/s and the other for English at 400 kc/s. Although a uniformly strong signal is obtained within the building, the field strength falls off rapidly outside, and at a distance of 3 metres from the building is inaudible in the receiver.

As will be seen from the accompanying photographs, the plastic receiver housing is little larger than a toothbrush case, and it is provided with a clip for attachment to the breast pocket. The tuned circuit inductance is a long single-layer winding over a Ferroxcube core. Fixed capacitors are switched across the coil to tune it to 300 or 400 kc/s. The rectifier is a Westinghouse germanium crystal, Type G54, tapped down the coil and working into headphones with a nominal resistance of 100 Ω.

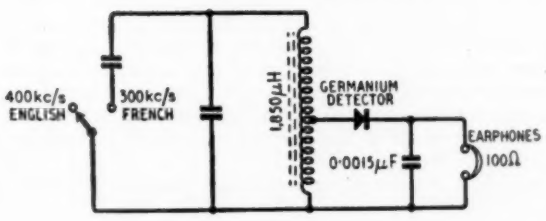
Volume control is effected simply by inclining the receiver unit from the vertical and so reducing the coupling with the r.f. field.

All journalists attending the conference were provided with earphone-receiver units and were thus able to move freely. Excellent reception, free from interference from the many electrical installations of the Palais de Chaillot, was reported in all parts of the hall.

The system is one which has many possible applications—for example, in co-ordinating activities in television and film studios or in providing alternative language dialogue for cinema patrons.

In conclusion, and as a tribute to the essential simplicity of the scheme, it is worth recording that the entire installation at N.A.T.O., including the provision of 200 receivers, was carried out in a fortnight.

Circuit diagram of the crystal receiver.



* Editor. *Toute la Radio*. Paris.

TRANSISTORS

1—Introductory Survey of Recent Developments

By THOMAS RODDAM

RATHER more than four years ago a new device, the transistor, was announced. Many of us, I suspect, looked rather sceptically down our noses: after all, *Wireless World* was describing semiconductor oscillators in 1924, and even the valves with secondary emitters built in, which give wonderful mutual conductances, still seem to be things we read about, not things we use. It was not very long, however, before it became apparent that the transistor was something in quite a different class. The problem became one of actually acquiring a transistor. Now, if you are privileged, you can get hold of a handful, and the production plans suggest that there will soon be some suppliers who are not completely overloaded by the orders from military sources and commercial associates. Most important is the fact that if you get a batch of transistors of a given type, they do not vary from sample to sample any more than valves do. The circuit problems are thus becoming reasonably straightforward ones, instead of the bespoke tailoring of the early transistors.

In this and succeeding articles I shall be drawing heavily on Bell Telephone Laboratories material.* The transistor was invented there, and the major theoretical and experimental studies have come from Bell, though some transistors have been made, and some papers published, in England, France, Germany and Russia.

In this first article, I do not propose to try to explain how the transistor works; but it is, perhaps, desirable to explain what it is. A transistor is a multi-electrode semiconducting amplifier device. That is as formal as I can make it at the moment, and it can be simplified by saying that almost all current transistors are made up of a small piece of germanium crystal having three electrodes arranged in such a way that the unit acts as an amplifier. In its standard mounting it is a small metal tube, half an inch long and less than a quarter of an inch in diameter. A unit of this kind will give perhaps 20db gain, and a pair in push-pull will give some hundreds of milliwatts of power. There is no heater: the estimated life is over 70,000 hours.

I have been rushing things rather in that last paragraph, and we must take a rather closer look at the nature of the transistor before we can consider any of the problems of circuit design. The commonly available type of transistor is the point type. This consists of a small slice of germanium, cut from a single crystal and mounted on a base through a non-rectifying contact. Two very closely spaced cats-whisker points are applied to the face of the crystal. Each of these, of course, will act as an ordinary diode rectifier, though for various reasons it need not be a rectifier of the highest class. If, however, you apply a negative supply through a resistance to one point, the *collector*, an important effect can be obtained. The current through the collector will be small, because it is flowing in the high-resistance direction for the rectifying point. Now apply a small positive voltage to the other point contact, the *emitter*. The base is taken as at earth potential. Current flows easily into the emitter, and an applied voltage of about 0.5V will produce something of the order of 5mA. As soon as the emitter is made to pass current, an additional current will flow in the collector circuit, and for a typical point transistor we shall get an extra 2 mA in the collector circuit for each 1 mA in the emitter circuit. Futher, since the collector impedance is normally high, we can put a high resistance in series with the collector to act as a load, although we only need to force the emitter current in through a low impedance. Typical values are: $R_{in} = 300$ ohms,

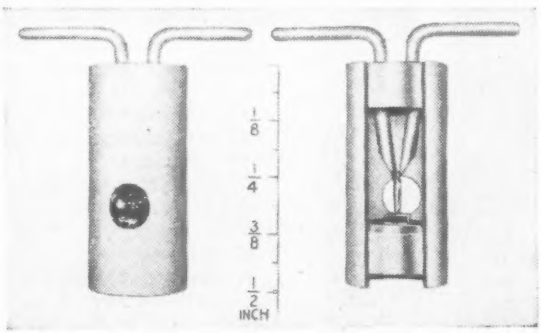


Fig. 1. Original form of the point transistor.

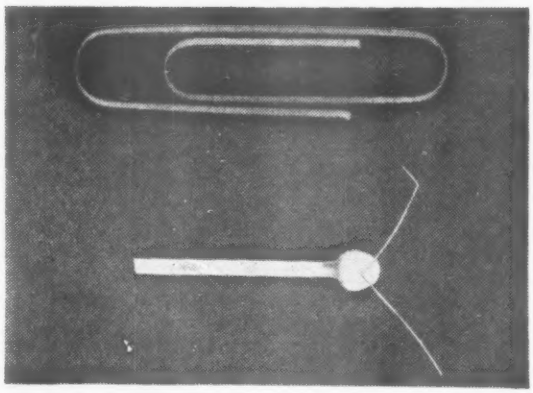


Fig. 2. Point transistor in "bead" form.

* Figs. 1, 2, 7 and 8 are reproduced from or based on an article by J. A. Moreton, *Bell System Technical Journal*, May, 1952.

$R_{out}=6000$ ohms, current gain$=2$ so that power gain$=2^2 . 6000/300=80$ times, or 19db.

It is possible to proceed discreetly through a long trail of network theory, analogue derivation and all sorts of blinding science to establish the principles of transistor circuit design. My guess is that I have read close on half a million words on transistors to date, and I want to get somewhere before the end of this few thousand. The simplest approach to transistor circuit design, therefore, seems to be to relate it to valve circuit design. We must keep one eye on the physics, so let us try a simple experiment.

We will take a transistor, Type A1698, and connect a -200 volt supply through 100kΩ to the collector, with the base earthed and the emitter open-circuited. We shall find that the collector current is about 1.6 mA and the collector voltage about -40V. Now we take the emitter back through 100kΩ to a potentiometer across a 2-volt battery, with earthed centre point. We adjust the potentiometer to cause a current of 0.5 mA to flow into the emitter. The collector current cannot change very much, because of the 100kΩ resistance, but the collector voltage drops to about -18V. This experiment is the equivalent of applying a voltage to the grid of a triode valve and measuring the change of anode current: just as we find a mutual conductance of, say, 4 mA/V, so in this transistor we have a mutual resistance of 44 V/mA.

Now we can carry out a second experiment. Let us fix the emitter current at 2mA, and vary the resistance in series with the collector battery so that we have first 5 mA and then 6 mA in the collector circuit. We find that a change of 1 mA in collector current produces 20 volts change, from -40 to -20 volts, at the collector. Just as a valve may have an anode impedance of 10,000 ohms (volts/mA), so the transistor has a collector admittance of 1/20,000 mhos.

This discussion has been directed towards the current control aspect of the transistor, because this is the vital thing to be borne in mind by the circuit designer; nothing but trouble greets the man who starts worrying about applying volts to the emitter. It is only in more advanced designs that you need to proceed beyond this simple view. Think always of the transistor as a valve dual, replacing current by voltage, and voltage by current, and you can go quite a long way.

Obviously, with this point of view, we can draw a set of transistor collector characteristics rather like a set of valve anode characteristics, except that now we measure collector voltages as a function of collector current using emitter current as a parameter. With a valve we use constant voltage supplies for testing: here we use "constant current" supplies, for example, a high voltage source with a high resistance in series, or even a pentode if we want to be pedantic. The curves shown in Fig. 4 are typical and on them I have also shown the 120-mW maximum dissipation hyperbola. If you turn the page upside down, you will see that this set of curves looks very much like a set of triode curves in shape, and I have added a loadline for a 10,000-ohm load passing through the rather arbitrary working point -20 V, -4 mA, corresponding to about 1.5 mA emitter bias. As you can see, the curves are fairly uniformly spaced, so we might put in 1.5 mA peak on the emitter, and get out nearly 20 V peak at the collector. There is some limiting near the collector *voltage* cut-off, just as a triode current cuts off in the full drive condition, but we have

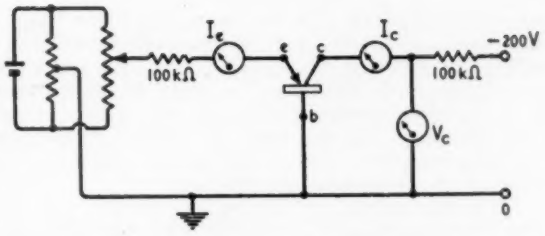


Fig. 3. Circuit for studying earth-base characteristics of point transistor.

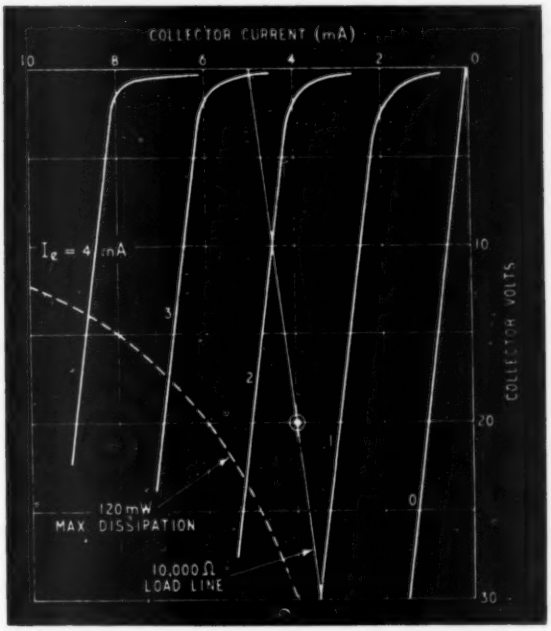


Fig. 4. Family of collector characteristics for a point transistor.

some 20 mW of output. Notice, by the way, that if we are using an output transformer, as we usually will be, we need only a 20 volt battery and 80 mW of power from it.

The input impedance of this type of transistor is of the order of 500 ohms. I shall come back to this input impedance question later, because it raises a lot of interesting problems. For the moment, however, it is enough to notice that we were applying 1.5 mA peak at the emitter, so that the input power is 0.56 mW and the gain, at this low level, is about 36 times in power, or 15.5 db. Let us be satisfied with this for the moment.

We do not want to use a separate bias source for the emitter if we can help it. Is there any way in which we can apply self bias to the emitter? We know that the emitter must be slightly positive with respect to the base, and that since the current from collector to base is -4 mA and from emitter to base is 1.5 mA, there must be 2.5 mA flowing into the base. If we put 100 ohms in the base lead, this will give us 0.25 volts negative at the base, or will make the

emitter +0.25 volts with respect to base if the emitter is returned to earth. This is about the right sort of value, and with our present information we can build up the circuit of Fig. 5, and vary the base resistance to get the best working conditions. Here, then, is our first amplifier circuit, with an input transformer designed to match the source to 500 ohms and a 10,000-ohm load output transformer.

Here, too, is our first headache. As we vary the base resistor, the amplifier bursts into vigorous oscillation. Let us see why. Forget for the moment the d.c. bias conditions and assume we have 250 ohms in the base. Let the collector current increase by 1 mA, thus producing an extra 0.25 volts drop in the base resistance. This will raise the emitter-base voltage 0.25 volts and thus cause the emitter current to rise by about 0.5 mA. But 0.5 mA emitter current rise will make the collector current rise about 1 mA more, and so it goes on until the transistor reaches collector voltage cut-off. The base resistor is a positive feedback element and if it is too large the circuit becomes unstable. Furthermore, since at very low frequencies there is no impedance in series with the collector, except the resistance of the transformer winding, it is possible for the collector current to run right up to perhaps hundreds of milliamps: you will not know exactly where, because if you are lucky the meter will burn out; if you are unlucky the transistor will burn out. For tests of the simple transistor circuit always make sure that you have a few thousand ohms in series with the collector and a few hundred ohms in series with the emitter.

Experimental Oscillator

This instability suggests that we should start off by using it in a controlled way. Instead of trying to make an amplifier, let us get our hands in on an oscillator circuit. We can make some extremely simple transistor oscillators and keep things under control at the same time. Then we can go back to the various amplifier possibilities.

First of all, notice that if we make the emitter go positive, we increase the emitter current, increase the collector current and thus make the collector more positive (or less negative, if you like it that way). Feedback from collector to emitter will thus be positive feedback: we can, therefore, provide positive feedback at one frequency by putting a series tuned circuit between collector and emitter. The circuit, using good protective resistance bias circuits, can be that shown in Fig. 6. This will oscillate if R is of about the same size as R_l, for reasons which we shall discuss later, and the amplitude of oscillation can be controlled by adjusting R. For experimental work, take a variable resistance of a few thousand ohms, start at maximum resistance and turn down until the circuit just oscillates. You can get an idea of the size of inductance by noticing that the reactance of L must be much more than R for good frequency control. Thus if we are working at 1,000 c/s we should use several henries, since we expect R to be several thousand ohms.

Frequency Stability

This oscillator circuit is not particularly stable in frequency. In fact the point transistor will not give enough gain to produce a really first-class oscillator—or a really first-class amplifier, either. Reasonable supply variations may produce changes in frequency of a few cycles per thousand, which is on the limit for even the simplest of broadcast receiver frequency-changer oscillators. There are some rather better circuits, which we shall consider later: the advantage of this circuit is that it is simple and all the variables are independent.

As you can see, this circuit lends itself to quartz crystal control: a crystal connected between oscillator and emitter should oscillate if it has not too high a resonant impedance. When I use this circuit with crystal control, I shall put a parallel-tuned circuit across either the emitter resistance or the collector resistance to make sure that the crystal is driven on its fundamental frequency, and not at one of the spurious frequencies which oscillator crystals provide for the unwary.

This article, which is trying to serve as an introduction and yet remain self-contained, would not be complete without a short discussion of the other main type of transistor, the junction type. To understand the operation of this it is first necessary to know that although pure germanium can be an intrinsic semiconductor, the actual material used for transistors is not quite pure, but may contain a few parts in 100 million of impurity. Certain impurities will fit into the regular crystal pattern, except that they may have one electron too many, or one too few. If there is one electron too many, it will float off homeless through the crystal lattice, and can act as a current carrier: the germanium is then said to be of *n*-type. If there is one electron too few in the cuckoo atom there will be a "hole" into which an electron could fit. An electron from a neighbouring atom can move into this hole, leaving its own place vacant, so that the hole appears to move. The hole behaves, indeed, rather as a sort of positive electron (it is *not* a positron), and can act as a current carrier. Germanium with an excess of holes is said to be of *p*-type. As you might expect, a point contact applied to a piece of *n*-type germanium does not allow electrons to flow into the germanium easily: the germanium is already overcrowded. Electrons will flow out easily, so that the low resistance condition is given for a positive voltage on the point.

Not surprisingly, a piece of *p*-germanium in contact with a piece of *n*-germanium is a rectifier, and since the contact area can be large, it is a rectifier with a much lower forward resistance than a point contact type.

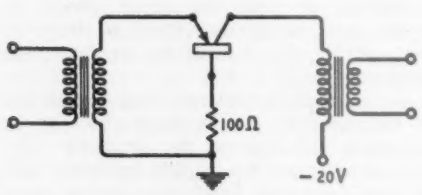


Fig. 5. Simple Class A amplifier using a point transistor.

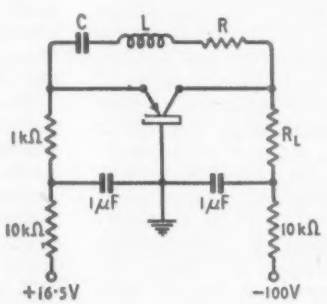


Fig. 6. Simple point transistor oscillator circuit.

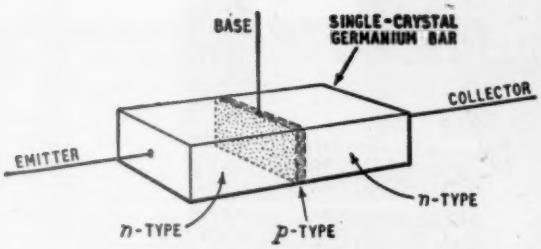


Fig. 7. Essential elements of the n-p-n junction transistor.

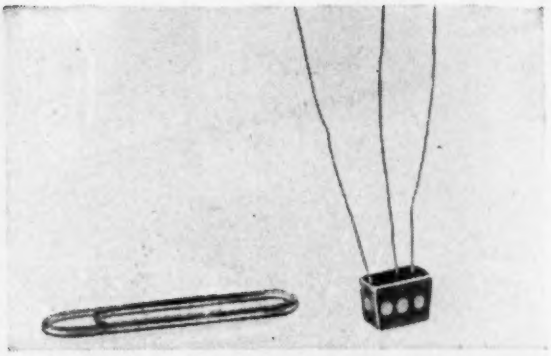


Fig. 8. Type M1752 junction transistor.

Once it was known how to make *n-p* junctions, and the technique is not easy, it was a short step to making *n-p-n* systems. A typical *n-p-n* transistor consists of a bar of germanium like that shown in Fig. 7, in which the area of the junction is about 0.01 sq cm and the base (of *p*-germanium) is about 1.5×10^{-3} cm thick. Wires are fastened to this unit, it is moulded in plastic and is then of the form shown in Fig. 8.

The *n-p-n* transistor is a much more attractive device than the point transistor. A gain of 50 db at audio frequencies is not difficult to obtain, Class A efficiencies of about 48 per cent are practicable, the noise is only 10-20 db above Johnson noise at 1,000 c/s, and lower at higher frequencies, and there seems to be no reason why it should not last for ever. The characteristics are rather pentode-like, compared with the triode-like characteristics of the point type transistor. Finally, and perhaps most important of all, it is so well understood that it can be designed to have predicted characteristics.

What is the future of the transistor? At the moment, if you can buy one, it will cost you nearly ten times as much as a valve. It will be much smaller, of course, and since you can work it down to very low levels, most of the components can be very small. Hearing aids and portable receivers can be reduced still further in size, and the batteries will be very much smaller, and last longer. For hearing aids, which are used for long periods, the reduction in running costs will certainly justify the high initial cost, and this may fall as production processes improve. Line communications will profit enormously, because the problem of heat dissipation is becoming serious in telephone carrier equipment, and all that heat is, of course, paid for in electricity supply. Long life means less maintenance, too. I need hardly point out the advantages of smallness, lightness and mechanical toughness in military applications. In general we may expect transistors to do all the jobs of small valves below about 10 Mc/s, with the possible exception of low-noise audio amplification. I propose, therefore, to cover the general problems of circuit design in future articles, interrupting the flow to discuss the physical side in more detail.

DO WE PLAN ENOUGH?

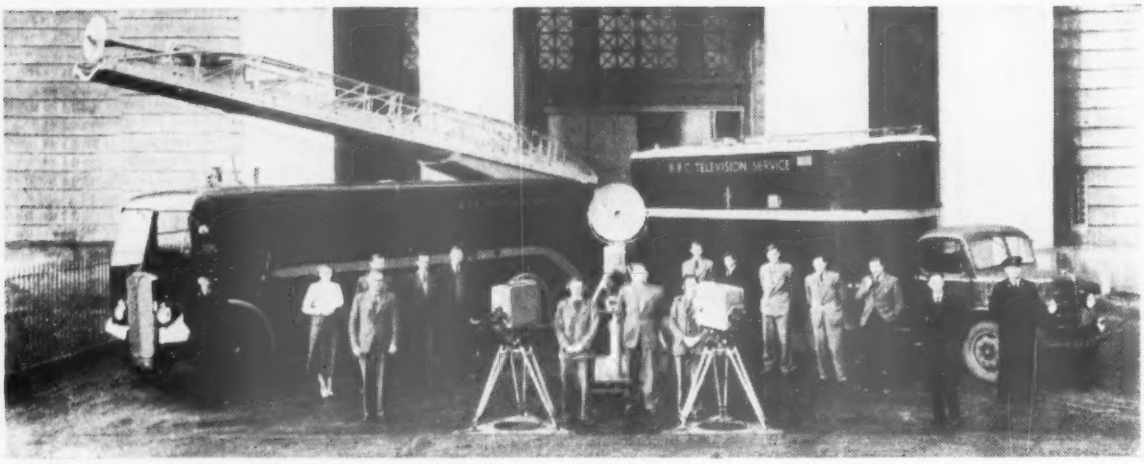
TOO many radio technical people fail to see the wood for the trees. They concentrate too much on the details of equipment design and not enough on the overall planning of radio systems. As a result of this lack of planning a great deal of effort is often wasted on the design of unsuitable equipment.

These views were implicit, if not stated in so many words, in a recent I.E.E. discussion on the subject of "How to Plan a Radio Project." The opener, J. Thomson, said that a failure in our technical teaching to-day is a lack of proper attention to radio system analysis. Radio textbooks tend to be design handbooks: the examination of what equipment is designed to do is discussed too casually. The same is true of radio courses in universities and technical colleges.

For a plan to be successful, said Mr. Thomson, it is necessary first to make a rigorous analysis of all the physical factors governing the operation of the project. "System analysis," as it is called, can save much waste and frustration. Equipment design must always await the outcome of this examination of the physical parameters.

Outlining the general procedure of planning, the speaker suggested that first the sphere of interest should be decided, for example, the frequencies and methods of modulation that might be used. Technical limitations, such as the outputs of the valves available and the degree of frequency stability, should then be assessed. Next, analysis of the proposed system would disclose the probable losses, noise factors, aerial requirements and also any unwanted effects such as cross-modulation. Only after these steps have been taken, and retraced if necessary, should the design of equipment commence.

In summing up, Mr. Thomson observed that the possibility of accurate prediction of performance is now well established, particularly in v.h.f. work, and that radio engineering is no longer an empirical art.



Operating Television O.B. Units

Problems of Planning and Producing Outside Broadcasts

By J. F. HARTWRIGHT *

THE five television outside broadcast units used by the B.B.C., although provided by different manufacturers, are essentially the same, each having three camera channels and sound equipment capable of handling up to eight microphones. It is not, however, the technical details of the equipment with which we are concerned in this article, but the operation of these O.B. units.

Owing to limitations of space in the vehicle every effort is made to keep the apparatus as small as possible and to employ a minimum of operational staff. Even so the technical team, including cameramen, vision control engineers, sound mixing and maintenance staff, normally numbers nine.

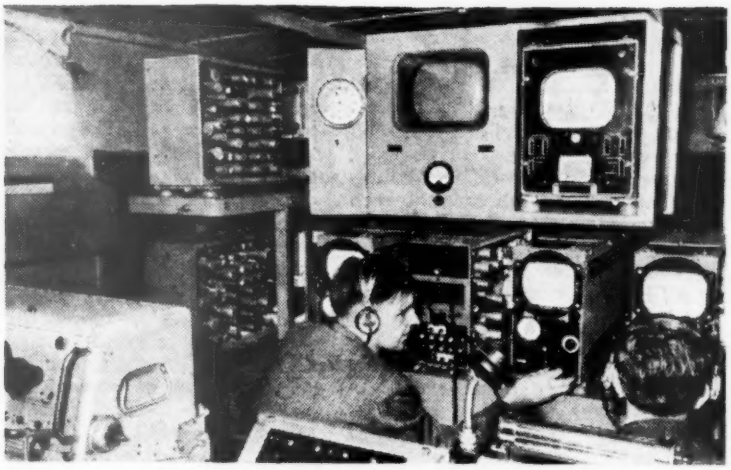
At those sites where a G.P.O. vision cable is not available a mobile radio transmitter is used to send the picture signal to the nearest available point for reception and injection into the Post Office television distribution network. This necessitates the inclusion of a further two engineers to man the transmitter. Thus, with the producer and his team, the total staff at an outside broadcast site may be as many as twenty. For distances up to about 20 miles a transmitter unit consisting of a 90ft extensible ladder carrying the aerial, a 185-Mc/s transmitter and motor generator (all carried in one vehicle) is used. For greater distances a series of e.h.f. relay links are employed.

The vision control engineers are responsible for the setting up and control of the cameras and associated equipment and on these adjustments depend the quality of the pictures as far as the output to G.P.O. cable or mobile radio transmitter. Beyond that point definition can, of course, be lost and great care must be taken when lining up prior to programmes to see that picture quality is maintained throughout the system. A test card is used in front of a camera if there is any sign of loss of definition and this picture is then examined at various points along the chain.

Considerable experience is required by the vision control engineers on outside broadcasts where very often there is little or no control over the lighting, costumes and scenery and little choice at times of even the camera positions. In these circumstances the cameras may be pointing from a dark to a light subject in a matter of a few seconds or sometimes even looking at a light source. Experience in the quick and accurate operation of the camera control unit is, therefore, very necessary. In addition to a picture monitor, the vision engineer also has before him an oscilloscope showing the electrical waveform of the picture. The control equipment enables accurate adjustments to be made to modulation, correct "sit" of the waveform above black level, to the shading of the picture, and to remote control of the camera iris. Pictures may easily be spoilt by a slight maladjustment of electrical focus, target voltage and camera tube beam-current controls or selection of the incorrect lens stop for the scene to be televised. The use of a lens stop that is too wide will cause, among other faults, a narrower tonal range because of the black compression if the camera tube is operated too far over the knee of the output curve.

All the outside broadcast cameras are now fitted with the image orthicon low-velocity pick-up tubes which are capable of working over a larger light range than any others yet available. The colour response is high in blue and green, good in yellow and red but

* British Broadcasting Corporation.

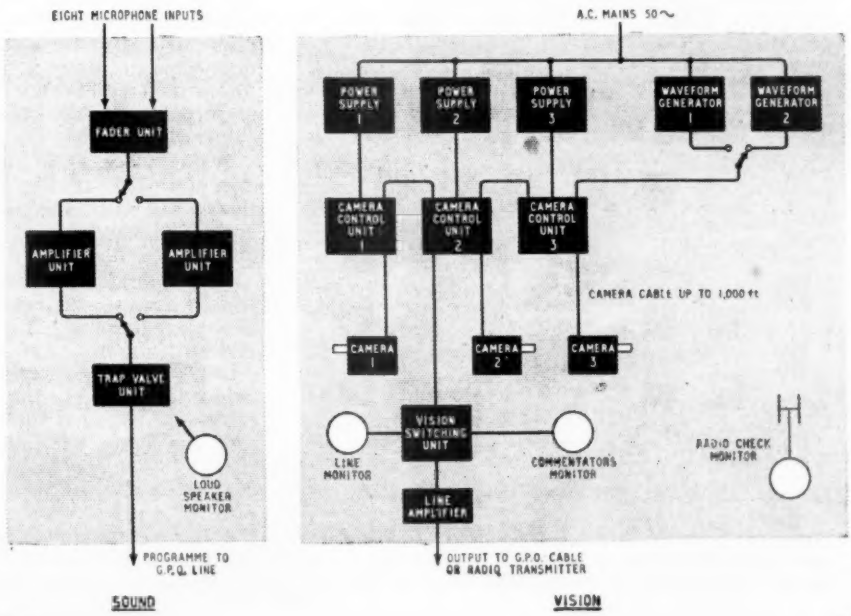


Interior of the Marconi mobile control room shown with the transmitter van on the opposite page. The vision engineers are adjusting the camera monitors, above which are monitors for the outgoing and radiated pictures

very low in infra red and, so far as the eye is concerned, renders colours in nearly their true tone gradation. A filter could be used to further improve the spectral response but would, of course, result in loss of sensitivity. The camera response to the various colours is: violet appears black, blue—dark grey, green—light grey, yellow—white, orange—light grey, and red—light grey.

The cameras are normally fitted with a four-position lens turret which is operated from the rear of the camera by the cameraman on instructions from the producer, the cameraman's other duties being optical control of focus and picture composition. A recent and most successful addition to the camera facilities is the Watson Zoom lens which enables a distant shot to be brought into "close-up" in a few seconds. With this lens the actual angle of view can be extended from roughly 4 degrees to 15 degrees or a focal range of 4 inches to 20 inches, thus a picture viewed at, say, 100 yards can be zoomed up to appear only 20 yards away. The action of zooming is very smooth and is controlled by a servo motor operated by the cameraman. The exact framing of a scene can be carried out without any delay due to changing lenses, the picture is uninterrupted and remains in focus throughout the operation. The aperture throughout the range given is f/6.3 and this remains constant when zooming. It is interesting to note that using a very fine pinhole in copper foil as a lens a recognizable picture can be obtained on a bright day, the focus control then operates as a zoom control. All the cameras are now fitted with electronic viewfinders. The loss of light in an optical viewfinder was such that in low light, though quite fair pictures were being obtained by the camera tube, the cameraman could not see the picture sufficiently well to maintain focus.

Owing to the specialized problems involved, the lighting for broadcasts from halls, theatres, etc., is carried out under the supervision of an engineer whose duties are mostly confined to this type of work. The method adopted is to raise the overall level of illumination so that satisfactory pictures can be obtained by the cameras using a lens stop of such a value as to give a reasonable depth of focus. This is the "foundation" lighting which should cover the whole of the programme area and be well diffused. Either incandescent or white fluorescent lamps can be used for this purpose, the advantage of the latter being good diffusion, but a faulty tube can cause a bad flicker. Incandescent lamps have the disadvantage that the efficiency falls off rapidly with mains variation—a 10 per cent decrease in mains voltage will drop the illumination by roughly 30 per cent. The effects lighting consisting of "key" and "modelling" light is next added by means of spot lights which are adjustable for coverage and intensity. "Key light" is arranged to give the effect of a single light source and to have a brightness of roughly the same as that of the foundation lighting when measured by an exposure meter looking towards the light source. "Modelling light" is used to accentuate any required feature, texture, shadow or background and to give effects such as lighted windows. Top lighting by means of spot lamps is undesirable with cameras fitted with image



Block schematic of the general arrangement of the equipment in a television O.B. van.

orthicon tubes owing to the dark halo it produces over light-coloured hair or any shiny surface such as a piano or bald head.

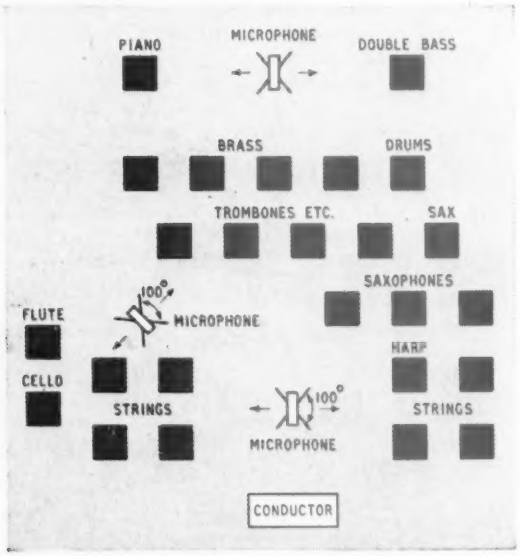
Where the special effect of dimming lights is required the picture quality will, of course, suffer, becoming blotchy and mottled as the dimming proceeds. This can be avoided if the effect is obtained electrically, by lowering the picture to black level on the camera control unit, but where a local audience is involved the dimming of lights may have to be carried out. Sometimes it is possible to televise a theatre show without any additional lighting being installed, but this also depends a great deal on the type of backcloth and costumes.

Owing to the high sensitivity of the image orthicon cameras, the amount of light required for satisfactory operation is considerably less than that necessary for the ordinary motion picture camera. With a black to white contrast of 2 to 1 or less, however, the cameras are not capable of producing a good picture. Because of this, good picture quality cannot be obtained from some outdoor scenes in winter. On the other hand, a lighting contrast ratio in excess of 20 to 1 is not desirable.

These are only the general principles of lighting for television. Many problems arise which prevent them being carried out in practice and many are the compromises and improvizations which have to be adopted.

Inter-dependence of Sound and Vision

The sound engineer is responsible for positioning and installing all the necessary microphones and for their balance and control during the programme. It is of course desirable that the microphones should be concealed from the view of the cameras when possible and that a minimum number be used to avoid unnecessary rigging. A proper balance has to be obtained between background effects and essential programme material and care has to be exercised in routing the microphone cables to avoid hum induction from power supply circuits.



Disposition of three microphones, having a figure of eight polar diagram, to give a reasonable balance where the seating arrangements of an orchestra cannot be altered.

The effect of the picture is in many ways dependent on sound balance. For example, it would be wrong if the cameras were using a wide-angle lens on a military band some distance away and the sound appeared to be loud and near as perspective would be lost. It would also be wrong, when televising a symphony concert, if the sound intensity were to vary every time a wide-angle picture was shown or for the orchestral balance to be upset by raising the volume of the strings when showing that section of the orchestra in close up.

The problem of separating the orchestra from the stage microphones is usually overcome by the use of microphones having a unidirectional cardioid characteristic near the footlights and a further microphone slung over the stage sufficiently high to avoid coming into camera shot. Microphone booms, as used in studios, can rarely be employed in outside broadcasts as there is seldom enough space available for manœuvring. When it is desired to pick up sound from some distance away, such as at the centre of a football field or cricket pitch, the parabola microphone is used. This arrangement consists of a moving-coil microphone fixed in the centre of a 4-foot diameter aluminium parabolic reflector, focus being adjusted by sliding the microphone along the axis of the reflector. The frequency response of this arrangement is not quite good enough for music but is adequate for speech or effects noises. It is usual to have the parabola placed in high position as it tends to pick up intervening noises in its path which might easily be louder than that from the required source.

In tidal waters, such as the Thames, it does not pay to leave an unattended microphone slung over the river side to pick up "lapping water effects." Either the tide recedes from it giving no effects, or it fills with water giving the wrong sort—a melancholy gurgle.

The miniature crystal microphone which is attached to the coat lapel of an interviewer has the advantage of being inconspicuous yet effective. The microphone preamplifier is carried in the pocket of the wearer and is supplied by a small dry battery. The battery has a life of a few hours only which is long enough for normal purposes. When using this type of microphone it has to be borne in mind that boiled shirts or medals can cause some trouble. The creaks from the former are magnified beyond belief and the clang of medals near this microphone sounds like a busy shipyard.

Walkie-talkie radio equipment has been used successfully where trailing microphone leads are impracticable but so far the quality has not been of a sufficiently high standard and the signal is subject to fading and interference.

The technical planning of an outside broadcast is usually commenced three or four weeks before the date of the programme. A planning sheet showing all the arrangements is then issued for information of the unit crew. Temporary cables are rigged on site a day before the arrival of the mobile control room. These cables are required for cameras, microphones, monitors, cue lights, telephones, power supplies and lighting. The cameras may be as far as 1,000 feet from the control vehicle.

On the production side, apart from all the usual problems of putting over entertainment for a large audience a wide knowledge of the possibilities and limitations of the medium is very necessary.

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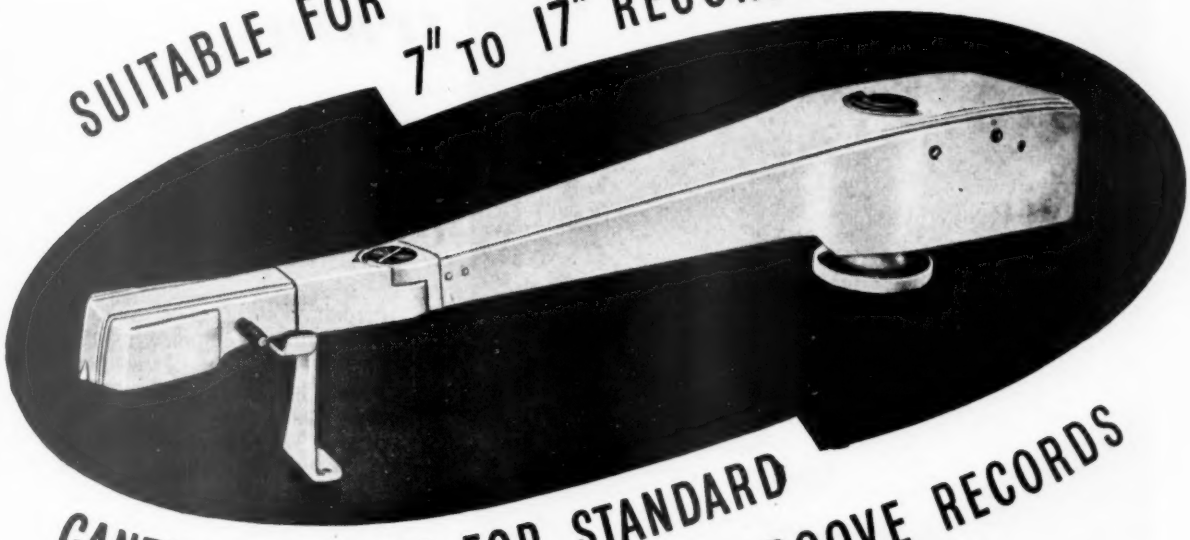

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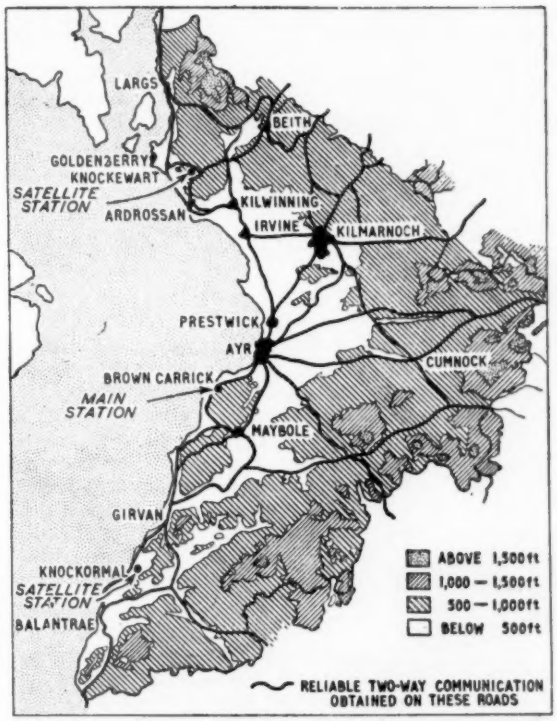


Sketch map of the county of Ayr showing the terrain and the main roads over which the police cars normally operate.

THE complete v.h.f. coverage of a hilly, and in places mountainous, area, such as Ayrshire, was virtually impossible with one station, so multiple-station working was accepted as inevitable for the County Police radio system. Since a mobile station may travel from one end of the county to the other, synchronous carrier-frequency working was another requirement. But could synchronous f.m. be achieved? The G.E.C. has shown that it can by providing the Ayrshire Police Authorities with the only multiple-station synchronized f.m. installation of its type in the U.K.

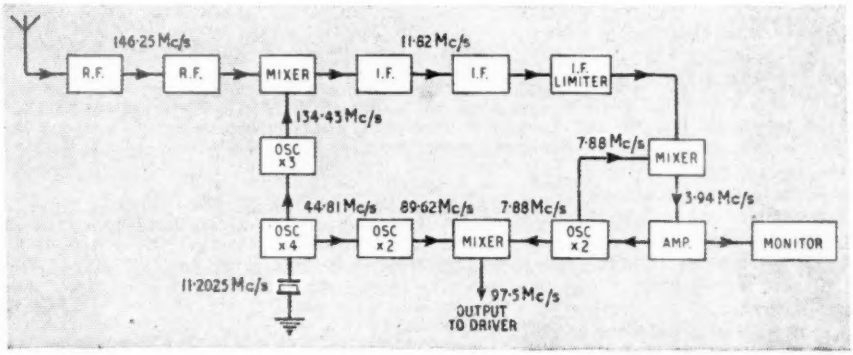
It was decided that the most satisfactory arrangement would be to use a master station near Ayr controlling two satellites, one to the north at Knockewart and the other to the south at Knockormal. The carrier frequency of the link transmitter is controlled by that of the master station, being derived from the same crystal, and this in turn, by means of suitable multiplying and dividing circuits, controls the frequency of the satellite transmitters. Thus it is possible to ensure complete synchronization of frequency of all three stations. Time delay circuits ensure that speech radiation is simultaneous from both the satellites and the master.

In the overlap areas the signals arriving at a mobile station will not necessarily be in phase. In practice, of course, this is not important because the overlap areas are not large and with a car moving at a normal speed the effect is unnoticeable.

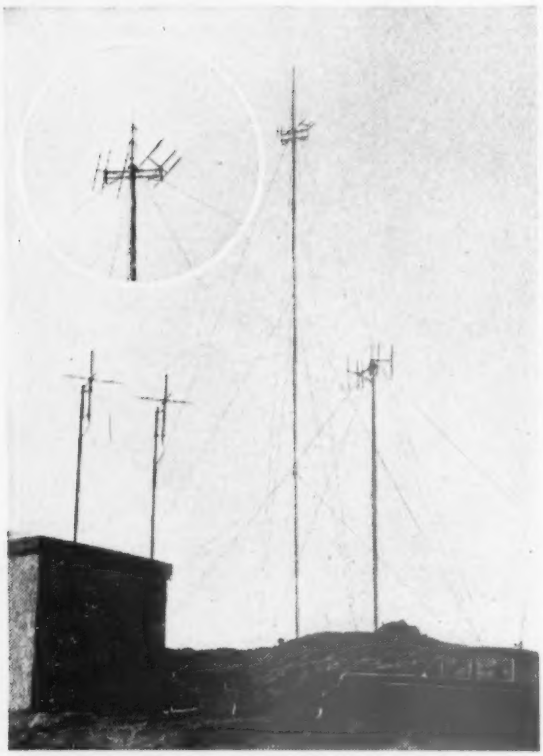
The main transmitter operates on a carrier frequency of 97.5 Mc/s and the link transmitters feeding the satellites operate on 146.25 Mc/s. Both the broadcast carrier and the link frequency are controlled by a master crystal working on 1.35416 Mc/s.

So far the problem is a simple one. At the satellite stations, however, not only has the intelligence, provided by the control station, to be conveyed from the link to the satellite (a simple enough matter) but also the carrier frequency of the link must be suitably divided and multiplied to produce the 97.5 Mc/s carrier for the satellite broadcast transmitter.

Two stages of r.f. amplification are interposed between the aerial and the mixer which is fed with a mixing signal at 134.43 Mc/s, derived from a twelve-



Block schematic of a satellite station showing the general arrangement of frequency division and multiplication to provide the transmitter's 97.5 Mc/s carrier from the link carrier (146.25 Mc/s).



On the main mast (see inset) are the broadcast aerial and horizontally polarized arrays for the transmitter linking the master station with the satellites. The link receiving aerials are on the smaller mast and the folded-unipole ground-plane aerials on the building are for the radio-control link to the H.Q. at Ayr.

times multiplied signal generated by a local crystal oscillator at 11.2025 Mc/s.

Thus an intermediate frequency of 11.82 Mc/s is produced and this signal is fed through two stages of i.f. amplification and an i.f. limiter to a second mixer, which is part of a three-valve regenerative divider. The "local oscillator" input to this mixer is at an intermediate frequency of 7.88 Mc/s, producing a beat frequency of 3.94 Mc/s (i.e., ¼ of the first i.f.), which is then doubled to provide the 7.88 Mc/s for the "local oscillator." This divider operates on any input signal whose frequency is near 11.82 Mc/s so that the f.m. appears on the 3.94 Mc/s and 7.88 Mc/s outputs.

The modulated signal at 3.94 Mc/s is also fed to a monitor for test purposes at the satellite.

Returning to the local oscillator, which provides the basic signal for mixing with the incoming r.f., another output, multiplied eight times, is fed to a mixer circuit at 89.62 Mc/s. Fed to the same circuit is a signal tapped off from the circuit, described previously, at 7.88 Mc/s. The sum of these frequencies, at 97.5 Mc/s, is then fed to the driver stage of the satellite broadcast transmitter. Since the 7.88 Mc/s signal is already modulated at the correct percentage no modulated problems arise in this transmitter.

It will probably be asked what happens to the frequency synchronization between master and satellite if the crystal (11.2025 Mc/s) in the link receiver drifts. In practice this does not matter, as the following example shows. Suppose that the frequency of oscillation of this crystal moves up 100 cycles. The multiplied signal fed to the first mixer will rise by 1,200 c/s and the resultant i.f. will fall by the same amount. Thus at the point from which the 7.88 Mc/s signal is derived there will be a drop in frequency of 800 c/s, and therefore a drop of the same amount at the mixer feeding the driver of the broadcast transmitter.

But this mixer is also fed from a frequency multiplier deriving its basic signal from the 11.2025 Mc/s crystal, so, instead of receiving a signal at 89.62 Mc/s, it will receive one 800 c/s higher. The frequency drop of 800 c/s on the other side of the circuit is thereby balanced and the mixer still provides a drive at 97.5 Mc/s. Thus full synchronism is maintained at all times.

In the reception arrangements for signals from the mobile stations, each fixed station receives the signals and feeds them to an audio mixer at the master station. The links in this direction operate at 154.3 Mc/s and 155.3 Mc/s. At the master station a delay network is again introduced so that received signals are synchronous. The signals are mixed in inverse proportion to the amount of noise present in each, thus avoiding degradation of a good signal by a bad one.

Simplex working is used between fixed and mobile stations but in the case of the link between the control station at the County Police H.Q. at Ayr and the master station at Brown Carrick duplex working is used. This enables the control station operator to over-ride an incoming signal. The control links operate at 146.8 and 154.8 Mc/s.

CLUB NEWS

Brighton.—The meeting of the Brighton and District Radio Club on February 3rd will be devoted to a discussion on the R.S.G.B. National Field Day. On February 17th, G. Austin will speak on "Tape and Disc Recording." Meetings are held at 7.30 at the Eagle Inn, Gloucester Road, Brighton, 1. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton.

Manchester.—Meetings of the Manchester and District Radio Society are held on the first Monday of each month at 7.30 at the Brunswick Hotel, Piccadilly, Manchester. Sec.: K. Brockbank, 17, Burleigh Road, Stretford, Lancs.

Peterborough.—The arrangements for the February meetings of the Peterborough Radio and Scientific Society include talks on automatic gain control in television receivers by C. J. Guscott (19th) and quality amplifiers by S. Woodward (26th). Meetings are held each Thursday at 7.30 at the society's headquarters in St. Paul's Road. Sec.: S. Woodward, 72, Priory Road, Peterborough.

Redhill.—The headquarters of the East Surrey Radio Club (G3ISR), is now the Ex-Service Men's Club, British Legion H.Q., High Street, Redhill, where meetings are held every 4th Thursday at 8.0. Sec.: L. Knight, Radiohme, 6, Madeira Walk, Reigate, Surrey.

Southend.—Arrangements have now been made for the meetings of the Southend & District Radio Society (G5QK) to be held in one of the electrical laboratories of the Municipal College. Meetings will be held on alternate Fridays; the first February meeting being on the 6th. Sec.: G. Chapman, Bell Hotel, 20, Leigh Hill, Leigh-on-Sea, Essex.

Stoke-on-Trent.—Meetings of the Stoke-on-Trent Amateur Radio Society (G3GBU) are held every Thursday at 7.30 at 2, Racecourse Road, Oakhill, Stoke-on-Trent. Sec.: J. R. Brindley, 45, Rosendale Avenue, Chesterton, Newcastle, Staffs.

Ravensbourne Amateur Radio Club, which is associated with the Downham Men's Evening Institute, Durham Hill School, Downham, Kent, meets every Wednesday from 8.0 to 10.0. A basic radio and television course is being conducted together with morse instruction classes. Sec.: W. H. J. Wilshaw, 4, Station Road, Bromley, Kent.

The Complex Number

Is It Really So Complex ?

By "CATHODE RAY"

I SOMETIMES wonder what the reaction of the uninitiated is when in technical literature they come across the word "complex." It is unlikely that anyone would guess what it means without being told, and I imagine that with only the non-technical meaning of the word to go on they get the impression that this is something very complicated and difficult to understand and had better be skipped. Certainly a dictionary does not shed much light on references to "the complex impedance of the circuit" or "the complex gain of the amplifier." One might guess that it meant that the circuit in question was a complicated one, made up of a lot of components (and one would be quite wrong!); as for "complex gain," one wouldn't have a clue.

It is true that complexity in this special sense is often bound up with advanced mathematics, but that is nothing to go by; so are + and − signs. The general idea (notwithstanding that the dictionary says "complex" means "not simple") is quite easy to grasp. It is the same idea as plotting a point on graph paper, given two numbers; or specifying a position on a map by grid references or by latitude and longitude. In the sense that having to cope with two numbers at a time is not so simple as just one, then I suppose the description "complex" may be justified. But it seems rather an exaggeration. One does not need a brilliant intellect to grasp the principle that if one is reckoning the quantities of two different kinds of things one has to keep a separate account of each and therefore always has two numbers. A position cannot be located by knowing it is 10 miles away; there have to be at least two numbers, say 6, 8, meaning that it is 6 miles East and 8 miles North, as in Fig. 1. This is the *rectangular* or squared-paper system. Alternatively they could be 10, 53°, meaning 10 miles away in the direction 53° anticlockwise from due East, as also in Fig. 1. This is the *polar* or angular system. Obviously it is necessary to know how the numbers are reckoned—whether East is positive or negative, and whether angles are measured clockwise or anticlock, and from which direction. These are the "conventions" that have to be agreed on beforehand, and if somebody didn't hear what was agreed it is too bad, because the numbers won't make much sense to him. But when he is in the know it is quite plain.

If the place P were known to be a station on a single railway line without junctions, then one number would be enough to fix its position relative to any starting point—for a line has only one dimension. It could be agreed to make positive numbers mean distance up the line and negative numbers distance down. But in Fig. 1 there are two dimensions; hence the need for two numbers. If we want to make an impression of great learning we can call such a two-part number a complex number. Then to people who know only the ordinary meaning of complex it will appear that we have mastered something very difficult, though in fact it is just as easy as before. If this manœuvre goes down well we can try developing people's respect for our brain-power into something like awe by deciding to describe distances measured eastwards as "real" and distances northwards as "imaginary," and distinguishing the latter from the former by attaching to them the mystic symbol "j," which, we shall take care to whisper (with the lights turned low and the gramophone playing "The Sorcerer's Apprentice"), stands for something beyond human ken—*the square root of minus one!* The finishing touch is to reveal that we not only comprehend this black art but actually practise it.

In this secret code, the complex number that would signify the journey from O to P in Fig. 1 is "$6 + j8$." Writing it "$6 + 8j$" or "$j8 + 6$" makes no difference. Three miles East and five miles South would be given as "$3 - j5$." It's as easy as that!

Specifying Impedance

Having made this bold step forward, to find that the apparently impregnable fortifications are a vanishing mirage, you can follow up the advantage in any good textbook. That was really all I set out to do—to encourage any who have hitherto been deterred by the awesome word "complex." But while we are at it perhaps I might go on to show some of the ways in which complex numbers are used in connection with circuits, and how they tie up with other ideas on the subject.

Impedance is one of the things that need two numbers—or a "complex number"—to specify

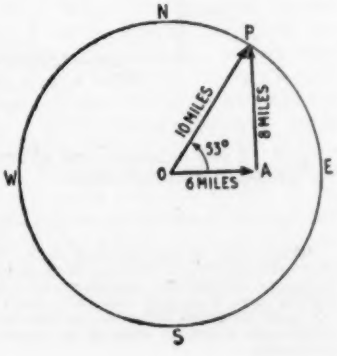


Fig. 1. Two methods of indicating the position of a point P in relation to O; each calls for two related numbers: the distances in two directions at right angles, or alternatively the direct distance and the angle measured from a reference direction. It is the same with impedance and other things.

properly, because although it is all reckoned in ohms it is made up of two parts that must not be confused by adding them together. Resistance is one part, and the other—reactance—can conveniently be kept separate by marking it "j." Although there are two kinds of reactance, these need not be kept in separate accounts, because the inductive kind is reckoned as positive and the capacitive kind negative, and I hardly need explain how to deal with them. With impedance, resistance, and reactance represented by the usual symbols, the complex-number specification of impedance in terms of its series values of resistance and reactance is

$$\mathbf{Z} = \mathrm{R} + j\mathrm{X}\ *$$

For example, the impedance of 20Ω resistance in series with 50Ω inductive reactance is $20 + j50$ ohms. If the reactance had been capacitive it would have been $20-j50$. When there are a lot of resistances and reactances in series the resistances can all be added together in one lot, and so can the reactances in another lot (paying due attention to + and − signs), and the two lots written as one complex number. The mathematically minded people like to describe this as separately equating the real and imaginary parts, but I hope nobody will get the idea from this that reactance is any less real than resistance. Misguided though the mathematicians may seem, there is a grain of method in their madness. What they have in mind is that j (and anything that appears to be multiplied by it) is not a real number, because there is no number which when squared is negative. But that need not worry us, so long as the method works. The important thing to remember is to keep all the j-marked numbers separate from the others. Thus, if the resistances of two impedances in series are 150Ω and 400Ω, the resistance of the whole must be 550Ω no matter what the reactances may be.

This would be very nice if everything were always in series, but what about items in parallel? Well, all the procedure for calculating simple d.c. circuits, with resistances only, holds good for a.c. circuits, complex numbers taking the place of simple numbers. Of course the same *apartheid* law for complex numbers has to be strictly observed. Calculating these more complicated circuits often involves multiplying one complex number by another. Take Fig. 2 for example; what is the impedance of the whole thing, expressed as one complex number? If there had been resistances only, we would have said

$$\frac{1}{\mathrm{R}} = \frac{1}{\mathrm{R}_1} + \frac{1}{\mathrm{R}_2}$$

which can be manipulated into

$$\mathrm{R} = \frac{\mathrm{R}_1\,\mathrm{R}_2}{\mathrm{R}_1 + \mathrm{R}_2}$$

The same thing applies to complex impedances:

$$\mathbf{Z} = \frac{\mathbf{Z}_1\,\mathbf{Z}_2}{\mathbf{Z}_1 + \mathbf{Z}_2}$$

With the details filled in from Fig. 2, this becomes

$$\mathbf{Z} = \frac{(\mathrm{R}_1 + j\mathrm{X}_1)\,(\mathrm{R}_2 + j\mathrm{X}_2)}{\mathrm{R}_1 + j\mathrm{X}_1 + \mathrm{R}_2 + j\mathrm{X}_2}$$

The denominator—the part below the line—is, metaphorically, a piece of cake; there need be no hesitation in "equating the real and imaginary parts":

$$(\mathrm{R}_1 + \mathrm{R}_2) + j\,(\mathrm{X}_1 + \mathrm{X}_2)$$

The multiplication in the numerator—the part above the line—is done according to the ordinary rules of algebra, thus:

$$\mathrm{R}_1\,\mathrm{R}_2 + j\,\mathrm{R}_1\,\mathrm{X}_2 + j\,\mathrm{R}_2\,\mathrm{X}_1 + j^2\,\mathrm{X}_1\,\mathrm{X}_2$$

and if we remember that $j = \sqrt{-1}$ we see that the $\mathrm{X}_1\,\mathrm{X}_2$ is transferred to the ranks of the "real," for $j^2 = -1$. So the numerator can be written as

$$(\mathrm{R}_1\,\mathrm{R}_2 - \mathrm{X}_1\,\mathrm{X}_2) + j\,(\mathrm{R}_1\,\mathrm{X}_2 + \mathrm{R}_2\,\mathrm{X}_1)$$

We now have Z as one complex number divided by another. Can this be reduced to a single complex number without going beyond the same rules of manipulation? It can, but a little dodge is needed to get over the immediate difficulty. It exploits the fact that when $(a + b)$ is multiplied by $(a - b)$ the answer is $a^2 - b^2$; non-squared terms go out. If we do this with the complex denominator, j goes out and we are left with a simple number. The factor to multiply by in this case is $(\mathrm{R}_1 + \mathrm{R}_2) - j\,(\mathrm{X}_1 + \mathrm{X}_2)$; and, of course, to keep the whole thing right it is necessary to multiply the numerator by the same amount. You will soon find that this "reducing" begins to cover the paper with vast numbers of symbols! But since it involves no new principle I won't waste *Wireless World* paper in the effort, but just report the end result of my private calculation, hoping it is the same as yours:

$$\mathbf{Z} = \frac{\mathrm{R}_1\,\mathrm{R}_2\,(\mathrm{R}_1 + \mathrm{R}_2) + \mathrm{R}_1\,\mathrm{X}_2^2 + \mathrm{R}_2\,\mathrm{X}_1^2}{(\mathrm{R}_1 + \mathrm{R}_2)^2 + (\mathrm{X}_1 + \mathrm{X}_2)^2} + j\,\frac{\mathrm{X}_1\,\mathrm{X}_2\,(\mathrm{X}_1 + \mathrm{X}_2) + \mathrm{R}_1^2\,\mathrm{X}_2 + \mathrm{R}_2^2\,\mathrm{X}_1}{(\mathrm{R}_1 + \mathrm{R}_2)^2 + (\mathrm{X}_1 + \mathrm{X}_2)^2}$$

This almost begins to justify the description "complex"! But when one fills in the values of R_1, etc., each of these two formidable expressions melts down into a single number of ohms, the first being R and the second X, so it is just a particular case of the basic $\mathbf{Z} = \mathrm{R} + j\mathrm{X}$. And Fig. 2 covers a very large variety of circuits, for R_1, X_1, etc., can each be the total of several items in series. In fact, with obvious extensions of the same methods it covers most of the circuits one is likely to need to calculate. Incidentally, don't you admire the beautiful symmetry of this equation? Note, too, that every separate term in it is ohms-cubed divided by ohms-squared, so is in ohms, as it ought to be; if this were not so it would be the sign of a slip somewhere, as I ex-

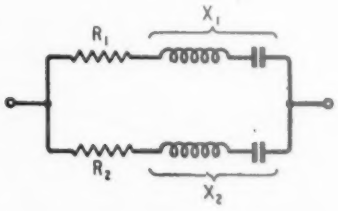


Fig. 2. A very important type of circuit, taken as an example of complex-number calculation.

*Heavy type is the standard device for distinguishing quantities that need complex or two-part numbers to convey the full information from mere magnitudes. An alternative is to distinguish magnitudes by putting them in straight waistcoats, thus: | Z |. But often one does not bother to distinguish either, unless there might be some doubt as to which was meant, or some other reason exists for emphasizing the distinction.

plained in "Dimensions" (November, 1951) with reference to this very same equation.

If you prefer to express the impedance as a resistance and a reactance in parallel, you can change over from the series values by means of the formulæ I quoted last month (but I don't advise you to try it with the particular specimen above !).

Going back to Fig. 1, you will remember that the complex number was not the only way of locating the point P. To say that it was $(6 + j8)$ miles from O would not be the most helpful form of the information to anyone who wanted to know how far it was away and/or in what direction, even if he knew the complex-number code. He would, however, knowing that the angle PAO is a right-angle, and having learnt at school the celebrated Theorem of Pythagoras, realize that $OP^2 = OA^2 + AP^2$, so OP would be $\sqrt{OA^2 + AP^2}$. Or if he were a little more sophisticated he would see that $\frac{AP}{OP} = \sin A\hat{O}P$, and hence $OP = AP/\sin A\hat{O}P$, which if he had a table of sines would be a little easier to work out. Alternatively $OP = OA/\cos A\hat{O}P$. But forget about this for a few minutes and dwell on the fact that $P\hat{A}O$ is a right-angle. In the complex number, 8 is added to 6 on condition that it is set off in the direction at right angles to the 6. Only in this way do they add up to 10. So one can look on the prefix "j" as the command "Left turn !" If we were to stick a j on the front of something that already had one—say jx—the result would be jjx, which if treated according to the rules of algebra would be j^2 x, which is equal to $-x$. This fits in beautifully with the turning idea, because the effect of two left turns is to reverse the direction, which is the meaning given to a minus sign. It continues to fit in however many times the process is repeated ; for instance, $j^4 = (-1)^2 = 1$, which is "as you were"—the same as four successive left turns.

The beauty of this simple code, whereby ordinary numbers represent easterly distances (or resistances) and j numbers represent northerly distances (or reactances), is that using only ideas that are obvious from Fig. 1 we can specify *any* direction—not just the four main points of the compass—or *any* impedance.

If one does not feel happy with trigonometry or even Pythagoras, then at least one can solve such problems by drawing a diagram to scale. Given the information "$6 + j8$ miles" it is a very simple matter (knowing this code as we now do) to draw the lines OA and AP to the scale of say 1 inch to the mile and find by actual measurement that OP is 10 miles in the direction 53° N. of E. Exactly the same method can be used for finding an impedance, given the resistance and reactance.

"Direction" of the Impedance

That is, so far as the actual amount or magnitude of impedance is concerned. What the "direction" of the impedance signifies may not be so obvious. Perhaps the best approach is to consider the voltages across R and X and both together when a current is passed through them, because this starts from the best-known electrical idea—Ohm's law. In one of its forms it says that the voltage across a resistance is proportional to the resistance and to the current through it ($V = IR$). If there are two resistances in series, R_1 and R_2, the same current passes through

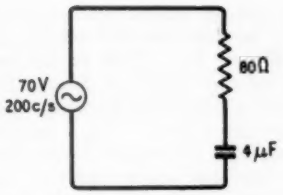


Fig. 3. *A numerical example to demonstrate complex numbers.*

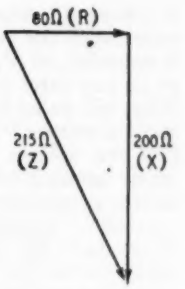


Fig. 4. *Impedance triangle for Fig. 3.*

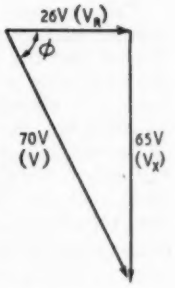


Fig. 5. *Voltage triangle for Fig. 3.*

both, so $V = V_{R1} + V_{R2} = IR_1 + IR_2 = I(R_1 + R_2)$. The same principle holds for a.c. and impedance, provided that the complex-number rules are followed. So we have $V = IZ = I(R + jX) = IR + j\,IX = V_R + jV_X$. This shows how to calculate the voltages across a resistance and a reactance in series, given the current ; and how to calculate the current, given the voltage across the whole impedance. (Strictly speaking V and I are complex or vectorial quantities, but there is no necessity to emphasize that here.) Just in case this is not all very old familiar stuff, we'll take an actual example presently ; but without stopping for that just now let us go on to take note of the fact that in this relationship—which obviously can be shown as a diagram of the Fig. 1 type—*direction* represents *phase*. Thus if "volts" were substituted for "miles" in Fig. 1, OA would represent the voltage across the resistance (V_R), AP the voltage across the reactance (V_X), and OP the voltage across the whole impedance (V) ; and the fact that OP is 53° relative to OA would signify that V was 53° ahead of V_R in phase. AP is 90° (or quarter of a revolution) more anti-clockwise than OA, and this agrees with the fact that V_X is always 90° (or quarter of a cycle) ahead of V_R, which is in phase with the current. So everything hangs together beautifully—the diagram, the algebra, and the measurable electrical conditions.

Now, for the sake of anyone who is still learning, here is the example—Fig. 3. The first thing is to find the reactance. Using the *Wireless World* Radio Data Charts (5th edition) No. 22, or the formula $X_C = 1/2\pi fC$, we find that X = nearly 200Ω. So the complex number for the whole impedance in ohms is $Z = 80 - j200$. What this amounts to can be found by drawing a scale diagram (Fig. 4) or working it out from $Z = \sqrt{(R^2 + X^2)}$. Either way the answer is just over 215. Knowing the e.m.f. and the total impedance, we can now calculate the current $I = 70/215 = 0.325$A. This passes through both R and X, so the voltages across them can be found, either by the Ohm's law calculation $V_R = IR = 0.325 \times 80 = 26$ and $V_X = IX = 0.325 \times 200 = 65$, or by the Fig. 4 triangle again, using the length of the longest side to represent the whole 70V, whereupon the lengths of the other sides represent to the same scale the voltages across the corresponding components (Fig. 5). Finally, the phase relationships of the various voltages. The voltage across positive reactance

is always 90° ahead of the voltage across resistance in series with the reactance; in this case the reactance is negative, so V_X is 90° *behind* V_R. That would be so in any case, regardless of the values of X and R. What has to be found is the phase angle between the applied voltage V and any of the others. Fig. 5 shows that the voltage V_R across the resistance leads the whole applied voltage V by the angle marked ϕ, which a protractor measurement shows to be just over 68°. To make the total angle between V_R and V_X equal to 90°, as it must be, V_X must *lag* V by the angle needed to bring 68° up to 90°, namely 22°. And if we remember that the current is in phase with the resistance voltage V_R, we see that it is 68° ahead of the whole applied voltage V. So now the whole situation is completely known.

This example ought to confirm how the complex number idea fits into the other ideas about a.c. circuits. To say that the impedance is 215Ω isn't the whole of the story, any more than saying P in Fig. 1 is 10 miles from O is enough to fix the position of P: 215Ω and 10 miles are merely the *magnitudes*. Relative position in two-dimensional space, and a.c. impedance, among a number of other things, need two data to specify them. In the Fig. 3 example we can either say that the impedance is $215\Omega \angle -68°$, meaning that its phase angle is 68° behind the resistance (which is the same as saying the voltage across the impedance is 68° behind the current), or specify the impedance as a complex number, in this case $80 - j\,200$ ohms. Sometimes one way is more convenient and sometimes the other. Given either, the other can be found, as I have just explained.

Calculating the Angle

One thing is missing, however. Whereas we worked out the magnitude Z in two alternative ways —by scale diagram and by calculation—we used only the diagram method for finding the phase angle ϕ. The diagram method is quite simple, but one may not always have a protractor handy, and even if one has the answer is not likely to be very precise unless unusual care is taken over the drawing. Actually I did mention a second calculation method for finding Z from R and X (or vice versa) which gave a clue to calculating the angle, but told you to forget it for a while so as to keep to one thing at a time. Now we can go back to the sophisticated method of calculation. It involves trigonometry, but only as far as Lesson One. With reference to Fig. 1, I mentioned that AP/OP = sin AÔP. In that case, AP = 8 and OP = 10, so sin AÔP = 0.8, and if you look up a table of sines you will see that the angle whose sine is 0.8 is (to the nearest degree) 53°. So that is one alternative to drawing the diagram. The other alternative I mentioned, cos AÔP = OA/OP, gives the same answer from a table of cosines. The scheme works with the electrical example; in Fig. 5, sin $\phi = -65/70$ (or, from Fig. 4, $-200/215$), and the table shows ϕ to be a little over $-68°$ (which, to be quite honest, was how I arrived at it in the first place! But with renewed honesty I confess I don't actually bother with + and − signs to find whether ϕ is leading or lagging—the tables don't help one in this, anyway. If in any doubt I make a rough diagram). Either sin or cos will do, but it is convenient to have still another way, which enables one to get ϕ straight from R and X (or V_R and V_X), without necessarily having to find Z first. The relationship is $\tan \phi = X/R$, or $\phi = \tan^{-1} X/R$ (read as "the angle whose tangent is X/R").

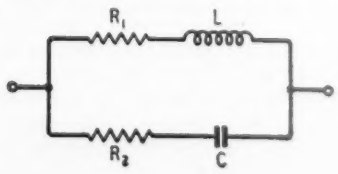


Fig. 6. *An example to work out. What is the resonant frequency?*

Summing up, then, an impedance consisting of R and X in series can be expressed either as a complex number, in terms of its components, thus,

$$\mathbf{Z} = \mathrm{R} + j\,\mathrm{X},$$

or by its magnitude and phase angle, thus,

$$\mathbf{Z} = \mathrm{Z} \angle \phi.$$

The conversion to magnitude and phase from the complex form is

$$\mathrm{Z} = \sqrt{\mathrm{R}^2 + \mathrm{X}^2}$$
$$\text{and } \phi = \tan^{-1} \mathrm{X/R}.$$

And the reverse conversion is

$$\mathrm{R} = \mathrm{Z} \cos \phi$$
$$\text{and } \mathrm{X} = \mathrm{Z} \sin \phi.$$

So still another form is

$$\mathbf{Z} = \mathrm{Z}(\cos \phi + j \sin \phi).$$

And yet another, which I am not going to try to explain now, but just mention to excite curiosity among any who have not yet encountered it is

$$\mathbf{Z} = \mathrm{Z}e^{j\phi}$$

In any of these, of course, R and X may be more or less complicated expressions, as in the equation for Fig. 2. The important thing is to be able to recognize a complex number when you see it, even when heavily disguised by this sort of elaboration. And, as we saw in connection with Fig. 5, the same codes (or notations) can be used for currents and voltages. Whereas our impedance picture is just a "still," showing a fixed phase relationship, the steadily increasing phase angle of an alternating current can be indicated by substituting for ϕ something that increases steadily with time. But that is another story.

Oh! I nearly forgot! The complex gain of an amplifier: what is it? If you have followed everything so far you will probably be able to guess the answer. Suppose when a 0.1-V signal is applied to the input of an amplifier the output is 15V. Then the voltage amplification or gain is 150 times. But that is only its magnitude, which is just part of the information, and not enough if one is considering using negative feedback, for instance. The phase is equally important, or how does one know that it wouldn't be positive feedback—or neither one nor the other? In other words the gain or loss of an amplifier or anything else that deals with a.c. is a two-part quantity, and can be expressed as (among other things) a complex number. This idea is the basis of feedback amplifier design—but I had better not start on that just now!

If you would like a little test question on the foregoing, here it is. What is the resonant frequency of the circuit shown in Fig. 6, if resonance is defined by current being in phase with applied voltage? Answer next month.

Television for Italy

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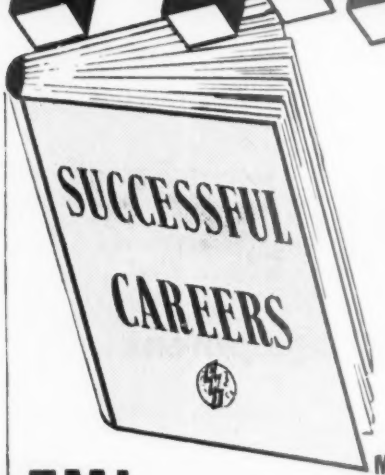

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Magnetic Powder Cores

Manufacturing Techniques and Applications in Radio and Telephony

By D. F. W. CHAMPION,* B.Sc.(Eng), Grad.I.E.E. and E. G. WILKINS,* B.Sc.

DURING recent years, magnetic powder cores have been increasingly used in telecommunications. These cores consist essentially of ferromagnetic particles, each coated with an insulating material, and the whole compacted to form a solid mass having considerable mechanical strength. It is apparent that the permeability of such a core, when measured under direct current conditions, is considerably lower than for the solid magnetic material. Under conditions of alternating flux, however, the position is complicated by induced eddy currents in the material which have the effect of lowering the measured permeability. This effect is more marked at higher frequencies. The circulation of eddy currents is restricted by subdivision of the material: at power frequencies laminations are satisfactory but at higher frequencies insulated powder must be used. As a general rule, at audio frequencies large particles and small amounts of insulation are used whilst at higher frequencies small particles and much larger amounts of insulation are necessary.

The manufacture of these cores involves quite complicated processing and it is not proposed to attempt a detailed account here. An outline of some techniques may be of interest, however, and for this purpose it is convenient to divide the processing into two parts, namely, the preparation of the magnetic powder and the preparation of the core from that powder.

One of the earliest methods used for the production of iron powder for use in magnetic cores was electrolytic in character. Ferrous sulphate was electrolysed using mild steel anodes, the iron being deposited on cathodes of polished steel sheet. The resulting iron was brittle and readily broken down in suitable grinding equipment. This powder was used for loading coils and although it was later superseded by nickel-iron alloys, electrolytic iron is still in use to-day for certain other applications. It must be pointed out, however, that various heat treatments and other processes are carried out before this powder is pressed into a core.

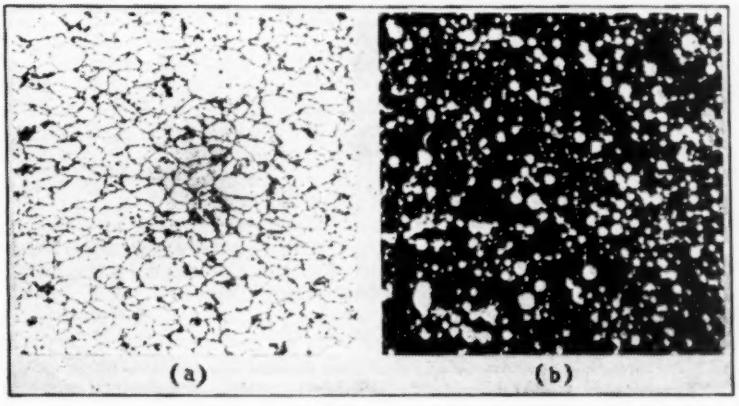
A later method, still in use to-day, was the introduction of an embrittling agent into nickel-iron and other alloys. The pure cast metal is too ductile to be readily broken down to a powder, but the use of such an agent results in a sufficiently brittle mass.

Both iron and its alloys can be produced by reduction from oxides, although in the case of alloys elaborate processing is necessary to obtain an alloy rather than a mixture of the component metals.

Finally, there is the carbonyl process. Iron pentacarbonyl, which is liquid at room temperature, is decomposed by heating in an enclosure. Iron is deposited on the walls of the enclosure in the form of almost spherical particles of approximately 5 microns diameter. This powder is of additional interest as it is an anomaly to the general conception of soft magnetic materials. Whilst most of these are mechanically soft, the so-called carbonyl iron is relatively hard.

Having outlined some of the methods of preparing magnetic powder we now turn to the next stages, namely insulation and core fabrication. Two main types of insulation are in common use, namely, plastic or resinous and ceramic. The former type is used where permeability and hysteresis loss are not critical, that is to say, in cores for use at radio frequencies. The insulating material is dissolved in some suitable organic solvent and mixed with the metal powder in a heated mixing machine. Ultimately the solvent evaporates, leaving a granular powder which is then pressed to form the core using pressures approaching

Fig. 1. Cross-sections of (a) high-permeability nickel-iron alloy core (× 200), and (b) low-permeability carbonyl iron core (× 500).



* Research Laboratories of the General Electric Company.

25 tons per sq inch. The pressed cores are then heated to near 200°C, thus polymerizing the insulating material, which also serves as a binder.

For many applications cores are required to have higher permeabilities and lower hysteresis loss than can be achieved by this method of insulation. The use of a ceramic coating, applied to the powder in a manner similar to the above, enables one to press cores at much higher pressures (up to 120 tons per sq inch) and to relieve the strain so introduced by heat treatment at temperatures up to 700°C. In this instance the mechanical strength of the finished core is mainly due to the interlocking of the particles of magnetic materials owing to plastic deformation at the high pressures used. The heat treatment of the core is a very important part of the processing. The rates of both heating and cooling are critical as well as the control of the temperature at which annealing is carried out. Cross-sections of a carbonyl iron and a nickel-iron alloy core are shown in Fig. 1.

Core Losses

Before going on to describe the types of powder core used for various applications, the question of core losses will be discussed. These losses include hysteresis loss, the magnitude of which is proportional to the area of the ferromagnetic hysteresis loop, eddy current losses induced in the material by the applied field, and residual or viscosity loss, the source of which is not fully understood at present.

These characteristics of a magnetic material are most readily deduced from measurements on a wound toroid. This shape is preferred since leakage field is a minimum and the mean magnetic path may be readily determined. Several systems exist for describing, classifying and measuring such losses and the following is a typical example.

The total effective resistance of a coil wound on a toroidal specimen and measured under conditions such that the induction is low (say 10 gauss), can be represented by the equation:—

$$R_{total} = R_{dc} + R_e + R_v + R_h$$

where the suffixes *dc*, *e*, *v* and *h* denote that the resistances are due to copper loss, eddy current loss, viscosity loss and hysteresis loss respectively. It can be shown for the low flux densities under consideration that the equation can be re-written in the form:—

$$R_{total} = R_{dc} + L\left(ef^2 + vf + hf\frac{NI}{l}\right)$$

where L is the inductance in henrys of a winding of N turns on a toroid having a mean magnetic path of length l centimetres, and f and I are the test frequency in kilocycles per second and current in amperes. By measuring this total effective resistance at several frequencies and currents it is practicable to separate out the values of e, v and h for the specimen. Typical values of the coefficients e, v and h are given in Table 1, together with permeabilities calculated from the inductance of a single layer winding on the specimen. It must be appreciated that the values of e deduced include the eddy current losses in the winding.

The measurement of the eddy current loss of the core alone (*e.c.* in the table) is usually carried out at a frequency of several megacycles per second where the eddy current loss is predominant and the loss in the actual winding may be accurately calculated and allowed for.

The many different forms of construction and properties of powder cores ensure that they are versatile components suitable for use over a wide range of frequencies and operating conditions. The following remarks are confined to their applications in the field of telecommunications.

The inherent high capacitance and low inductance of a telephone cable severely limits the distance over which it is possible to transmit intelligible signals, and it was suggested by Heaviside in 1887 that the addition of inductance to the cable would reduce considerably both distortion and attenuation. Many years later it was demonstrated that loading coils wound on low-loss cores inserted in series with the cable at intervals would produce the desired effect.

The type of core used in telephone loading coils must conform to a rigid specification. The effective resistance of the coil must be as small as possible over the whole frequency band in use; it must be stable with regard to inductance and losses with time and after the application of large signalling currents; it must have a high insulation resistance, and be electrically symmetrical to prevent the introduction of cross-talk.

Experiments soon showed that, on one hand, the air-cored coil had a prohibitively large d.c. resistance, whilst stampings had very high losses and poor stability. Hence a compromise between the two was sought. The earliest loading coil cores used were made by winding insulated iron wire into a toroidal core. Further development produced, in 1915, a core made of electrolytic iron powder insulated with shellac and pressed into a solid core, but the high losses of these cores stimulated work which led to the introduction of nickel-iron alloy powder in 1930. Since low values of induction are gener-

TABLE I
Core Loss Coefficients

Material	Binder % by volume (approx.)	Nominal forming pressure tons/sq inch	Typical core losses				
			u	e	v	h	*e.c.*
Annealed electrolytic iron ..	5	50*	90	10	40	500	—
	1	50	90	8	30	1250	—
80/20 Nickel iron	35	100*	12	—	1.5	3.5	0.04
,,	17	100*	50	1.0	4.0	19.0	0.30
,,	5	100*	120	2.0	7.0	60	—
Ternary alloy with nickel and iron	35	100*	12	—	1.5	3.0	0.04
	17	100*	50	1.0	4.0	14.5	0.30
in approximately 80/20 ratio..	5	100*	140	2.0	8	40	—
Carbonyl iron—							
Grade MC ..	30	20	14.5	—	14	13.5	0.02
Grade ME ..	30	20	11.0	—	2.0	1.0	<0.02
Grade MF ..	30	20	9.0	—	1.0	<0.3	<0.02
Iron from oxide reduction ..	30	20	19.0	—	14	34	0.06

* These cores are heat treated at a high temperature to relieve strain.

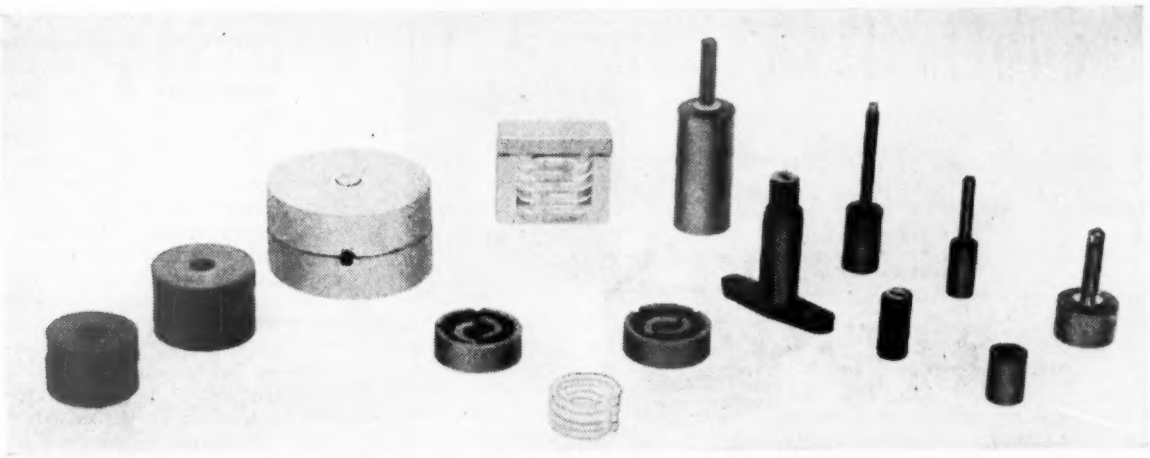


Fig. 2. Powder cores for use at radio frequencies.

ally the rule, the loss separation outlined above may be used to specify the maximum permitted losses. The initial permeability, or rather the permeability at very low inductions, must be as high as possible consistent with low values of hysteresis, eddy current and viscosity losses. Nickel-iron alloys and ternary alloys containing nickel and iron in the approximate ratio of 80/20 are most commonly used for powder cores in this frequency range. The particle size is in the region of 15 to 50 microns. The highest permeability available at present is 140; in such cores the volume of insulation occupies about 4 per cent of the total whilst in cores of the lowest permeability of 14 some 30 per cent of the volume is occupied by insulation.

Telephone Circuit Applications

The selection of a core for a loading coil depends on the type of telephone circuit in which it is to be used. For high quality transmission, as required for broadcast or music lines, low-permeability low-loss cores are used. For main trunk cables and minor trunk cables cores of high permeability and low losses (particularly hysteresis loss) are necessary, whilst for town and exchange lines the higher permeability core with its larger losses is satisfactory. The toroidal core is always preferred for this application because of its small external field. The wound cores are sealed in cylindrical containers and stacked in vertical columns in a steel loading coil pot, which may contain up to 400 coils. They are then connected to a central stub cable and the pot is sealed ready for installation. The spacing of the pots along the telephone cable is usually about 2,000 yards.

Alloy powder and carbonyl iron cores are used extensively in filters for multi-channel carrier telephony systems. Here again, the cores must have extremely low losses combined with a very small temperature coefficient of inductance.

The application of magnetic powder cores in radio may be conveniently divided into two groups, namely, those used at radio frequencies and those used at lower frequencies in ancillary circuits.

The first serious attempt to manufacture cores for use at radio frequencies was the introduction of Ferrocart in Germany some twenty years ago. It was made by depositing a layer of insulated iron powder on to paper which was then rolled into tubes for use as plug cores, or a number of layers were formed into a block before being machined to a suitable shape. This material had a comparatively low permeability, less than ten in toroidal form, and was superseded in 1935 by cores made by methods similar to those in use to-day.

Because the predominant core loss at high frequencies is that due to eddy currents, the modern radio-frequency core is made of very fine powders having a particle size in the range 5 to 10 microns and about 30 per cent by volume of insulating material. Carbonyl iron is commonly used for the highest quality cores, whilst fine iron powder is used for those of lesser quality.

Although available in many different forms, the most widely used types of radio frequency core are the completely enclosed pot core and the plug core. The pot core may have an effective permeability of up to six and provision is usually made to adjust the inductance of the coil by about 5 per cent by the insertion of a plug in a central hole in the core. The plug core, used widely for such applications as tuning coils and i.f. transformers, is usually fitted with a screwed brass insert or a thread is ground into the core itself so that the inductance may be varied by changing the relative positions of the coil and core. Plug cores may have effective permeabilities up to eight, but for the screwed cores the figure is usually in the region of two. Certain types are suitable for applications at frequencies over 50 Mc/s.

Cores for Television

The rapid developments in television receivers during the post-war years have resulted in several new applications of the powder core, the most noteworthy being in components for line time-base circuits. The trend towards the use of energy recovery systems has necessitated the use of efficient output transformers and deflection yokes. The output transformer not only matches the deflector coils to the output valve but also supplies the e.h.t. for the cathode ray tube from the flyback pulse, and very often the heater current for the e.h.t. rectifier. As well as having low magnetic losses, a core material for this application must have a reasonably high permeability to keep the

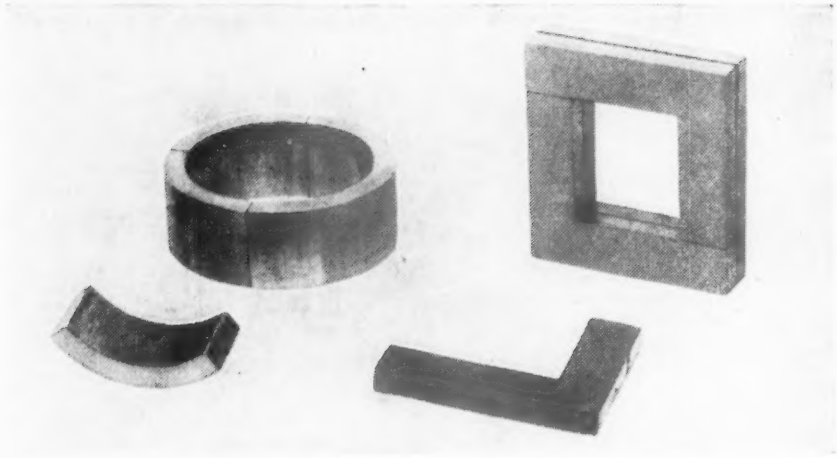


Fig. 3. Television cores : (left) deflector coil yoke ; (right) line time-base output transformer core.

copper used to a minimum, and to reduce leakage inductance to a tolerable amount. One such time-base output transformer core is shown in Fig. 3. It consists of four L-shaped cores which are assembled with staggered butt joints. The windings are usually placed on one limb. The technical advantages of this type of core are that it is more efficient and easier to assemble than stampings, it may be operated at quite high flux densities and it is extremely quiet in operation.

Deflector Coil Yokes

The powder-core technique has also been successfully applied to the manufacture of deflector coil yokes which have hitherto used stampings or iron wire. There are two designs available, the castellated type and the plain ring in segments (shown in Fig. 3) which are finally clamped or cemented together. The major advantage of the castellated form of yoke is that undue care need not be taken in winding the coils since the field distribution is almost wholly controlled by the shape of the internal teeth.

The material used for these television applications is usually a pure iron of large mean particle size (about 100 microns) with a relatively small amount of insulation. The insulation may be either ceramic or resinous and amounts to about two per cent of the volume of the core. In order to enhance the permeability of the core in a given direction, some manufacturers use iron particles processed in such a way as to render them plate-like.

The propagation of radio interference may be by direct radiation from the offending equipment, by radiation from wiring connected to the equipment, or by conduction along the wiring directly into the receiver by way of its power supply. The first method may only be cured by screening the equipment itself, but the last two causes of interference may be remedied by the use of suppressors in the wiring.

The employment of magnetic cores in suppressor coils results in a reduction in both the volume of the coil and the amount of copper, and hence copper losses. Early suppressor cores were of the laminated variety, but, because of the low permeability of these cores at radio frequencies caused by eddy current shielding, the open type of construction proved essential, giving an effective permeability of less than ten.

Compared with other applications, the requirements of cores for interference suppressors are not very stringent. The essential feature of such a coil is that it should have a high impedance over a wide frequency range, which implies that a fall in permeability with increasing frequency is not detrimental to its performance. The losses in the core are comparatively unimportant since, although they cause a drop in the maximum impedance of the coil at its self-resonant frequency, they result in a broadening of the impedance-frequency curve.

The characteristics of a core suitable for suppressor coils are that it should preferably have a permeability of greater than fifty in toroidal form with polarizing fields of about fifty oersteds, and this permeability may fall above a frequency of 200 kc/s. Alloy powder cores have been used very successfully for this application, but in general, lower grade cores similar to the pure iron type described above adequately meet these requirements.

By suitable selection of materials, it is possible to satisfy many requirements by the use of powder cores. Apart from the obvious advantage of low losses, these cores have the merits of being prefabricated to precise dimensions, of having excellent stability and linear magnetic characteristics and of being usable at high inductions.

INDUCTANCE OR CAPACITANCE?

IN a lecture to the British Sound Recording Association last month, A. N. Crowhurst, A.M.I.E.E., discussed the basic principles of equalizers, filters and tone controls and showed how a required characteristic could be broken down and synthesized from a combination of simple "step" circuits, resonant sections, etc.

In the discussion which followed, several speakers commented on the fact that the lecturer had in many instances included inductances in his circuits and asked if this were not a retrograde step, since the tendency for some time had been to use only resistive or capacitive elements in the interest of simplicity, immunity from hum pick-up and (*sic*) less phase distortion. It was pointed out that as far as phase displacement was concerned, inductance differed from capacitance only in sign and not in magnitude, and that hum pick-up was a matter of design and could be overcome by the use of "binocular," "astatic" or toroidal windings.

Support for the lecturer's case for a more extended use of inductance in equalizer design came from other experienced designers in the audience, who pointed out that in the sizes of the order of millihenrys, which are common in filter design, an inductive component is often more reliable and cheaper than an equivalent capacitive element.

Suppression of Ground Reflections

By MICHAEL LORANT

Applications of Optical Methods to Microwave Communication Systems

A METHOD for alleviating one of the difficulties confronting the users of line-of-sight microwave communications — service interruptions resulting from ground-reflection effects—has recently been devised by the U.S. National Bureau of Standards through the application of optical methods and theories to microwave techniques. In particular, a method based on the Huygens-Fresnel diffraction theory has been developed for the suppression of the ground reflections in microwave systems.

Interruptions may occur when the direct wave from the transmitter and the ground-reflected wave destructively interfere with each other at the receiver. Although it is possible to set the receiver at a point of constructive interference, subsequent atmospheric changes usually shift the spatial interference pattern (the so-called lobe pattern) so that an interference minimum frequently occurs at the receiver.

In the new method reflected wave-suppression is achieved by setting a small screen of the proper size on the ground at the "reflection point" in the path. The reflected wave at the receiver is then substantially diminished, to an extent depending on the smoothness of the ground plane. The screen is designed to block only a small part of the re-radiation from the ground to the receiver; the remainder of the reflected radiation adds up to zero at the receiver. The direct wave undergoes little or no modification.

The new wave-suppression technique is based on the optical principle that the wave field transmitted from a point source to a point receiver under free-space condition becomes zero if half of the first

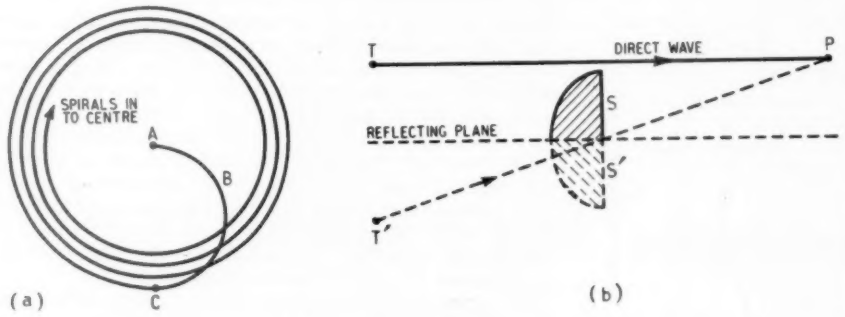
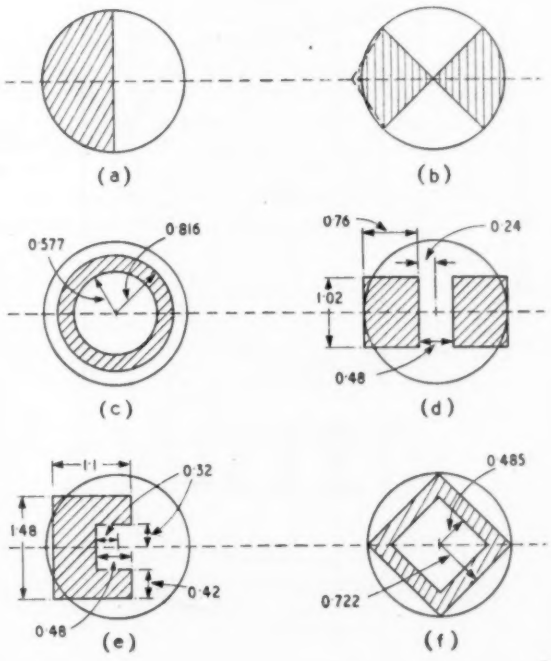
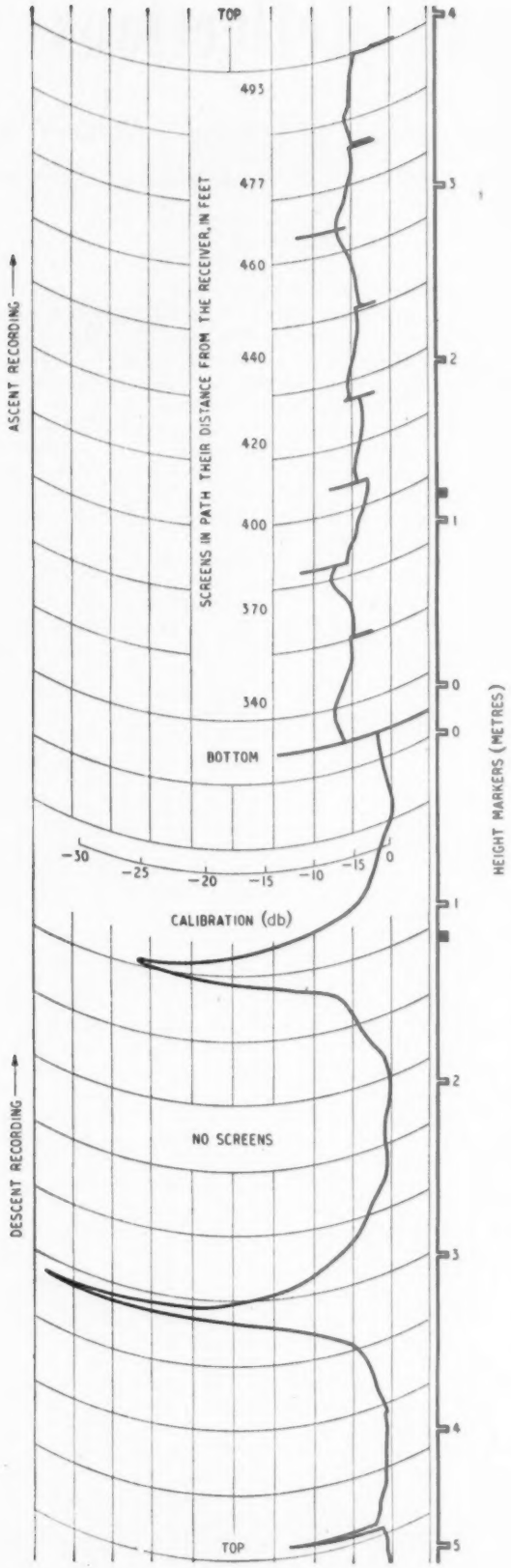


Diagram illustrating the application of optical principles to microwave techniques for the suppression of ground reflections. Attempts are made to nullify the effect of the ground at the receiver by placing an opaque screen at about the midpoint of the path between the transmitter and the receiver. The screen is erected so as not to interfere with the direct ray from the transmitter (T). The ground-reflections are considered as originating at an image transmitter (T') below the reflecting plane and are radiating toward the receiver (P) along a path that passes through the screen (S) and its image (S').



Drawings of zonal screens to give suppression of microwave ground-reflections. The dimensions of the screens are given in fractions of the radius of the first Fresnel zone : the outside circle of each drawing represents the periphers of the first zone. The dashed line through the centre of the circles denotes the ground plane. In practice only the upper half of the screen is constructed ; suppression is accomplished through the combined effect of the actual screen and its image. Screen (b) indicates how the semi-circular screen (a) can be cut into sub-sectors and still suppress the reflected wave. Screen (c) is an annular ring that nullifies only one-third of the zone area but is fully effective because it is opaque to the midphases of a zone. The remaining two-thirds of this zone would also be a screen. Screen (d) is composed of two rectangles which are structurally convenient and produce a broad null area. Screens (e) and (f) offer convenient variation for isolated application in which permanent structures may be utilized.



Fresnel zone is blocked so that the remaining diffracted contribution of the zone is halved in amplitude and unchanged in phase. The reduced contribution of the first zone is then cancelled by radiation from unblocked zones.

One of the screens developed by the Bureau takes the form of an opaque quarter-circle. The screen is erected where the reflected ray from the transmitter strikes the ground. The plane of the screen is perpendicular to the path, and its radius is equal to that of the first Fresnel zone in this plane. Thus, the quarter-circle blocks one half of the first Fresnel zone for the ground-reflected wave; according to optical theory, the remaining contribution from this zone is cancelled and the effect of the image source is effectively eliminated at the receiver.

To obtain experimental confirmation of the reflected-wave suppression, the investigators used a 4,500-Mc/s transmitter. Horizontally polarized signals were radiated from a horn set about 14ft above the ground and received with a similar aerial about 800ft away on a 50ft tower. The received power was recorded as a function of height of this aerial.

One of the experimental wave suppressors is composed of two triangular screens with edges of 7.3, 6.6, and 5.4 feet. When the path was not obstructed by the suppressor, the receiver recorded a well-defined interference pattern of minimum and maximum signal strengths as the receiving aerial was raised and lowered on the tower. But when the triangular screens were placed in their proper position, the influence of the reflected wave was substantially eliminated at the receiver. The field strength of the remaining direct wave was 6 db less than that of the signal at a point of maximum interference when no suppressing screen was used. By moving the receiving aerial above and below its normal operating position it was possible to determine whether the reflected wave was really suppressed or merely shifted in phase.

In practice, microwave radio relay paths are usually 20 or 30 miles long, and the transmitters generally operate at a frequency of about 4,000 Mc/s (wavelength 7.5 cm). Under these conditions, the first Fresnel zone is 80 to 100 feet in radius at the middle of the path, and the radius of the main suppressed area at the receiving point is about 8 to 10 feet. Fortunately, the aerials commonly used for these microwave systems are about 8 feet in radius. To accomplish nearly complete suppression, the screen is positioned on the path to within a few feet of the centre. For a first zone of 80 feet, a satisfactory screen is a rectangular structure made of fine mesh wire netting mounted on poles 40 feet high.

A number of experiments using differently shaped screens have indicated that troublesome reflections can be eliminated by small screens erected in the path or by utilizing obstacles permanently located near the proper position in the path.

Receiver-recording of signal strength versus height and time of a microwave radio relay with and without the zonal screens. Without screens and when the aerial is lowered from 4 to zero metres the interference of the reflected ray creates a well-defined pattern. With two triangular suppressing screens and with the aerial at 4 metres, the influence of the reflected wave is mostly eliminated.

STEREOPHONIC AMPLIFIER

THE Stereophonic amplifier Mk. VII according to users gives the highest quality of any reproducer so far produced. This high quality is to be expected when the particular points are considered.

The large reduction of intermodulation distortion and Dopler effect is achieved by completely separate amplifier channels for the high and low frequencies terminating in separate speakers. The latter may be separated by any convenient distance to prevent pressure wave modulation and it is unnecessary to restrict the bass to prevent marring treble.

In each case the speaker is damped by a minimum of 12 times at audible frequencies to prevent speaker resonance, and the cross-over is very fast, approximately 28 db for the first octave. A control is provided to vary the power applied to the treble speaker, to compensate for its efficiency compared with the bass speaker and a frequency record reveals the absence of dip or rise in output at crossover frequencies.

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FURTHER NOTES ON THE F.M. FEEDER UNIT

Circuit Modifications for EF91 R.F. Valve; Avoidance of Parasitic Oscillation in Frequency-changer and I.F. Amplifier

By S. W. AMOS,* B.Sc. (Hons), A.M.I.E.E., and G. G. JOHNSTONE,* B.Sc. (Hons).

SINCE the publication of the original articles on the f.m. feeder unit in the September and October, 1952, issues, some correspondence has been received concerning the performance and construction of the unit. The points raised are discussed here for the benefit of other prospective constructors.

(1) The pre-emphasis circuit of the B.B.C. f.m. transmission is 50 μsecs. The values of the components R_{19}, C_{24} specified in the original article give approximately 75 μsecs de-emphasis, implying a small relative loss at the upper audio frequencies. To avoid this loss, the values of R_{19} and C_{24} should be amended; 47 kΩ and 0.001 μF are suitable.

(2) It has been pointed out that the quarter-wave section of feeder used in the balance-to-unbalance coupling at the dipole has a dielectric consisting mainly of air; its electrical length is therefore equal to its physical length and should be 2 ft 6 in.

(3) Some of the units constructed have suffered from parasitic oscillation in the frequency-changer or i.f. amplifier. These oscillations usually manifest themselves as "dead" carriers, but in one particular unit they caused a continuous hiss in the a.f. output. The oscillations are produced by a Lecher-wire mechanism between the leads to valve electrodes. Oscillation in the i.f. amplifier can be eliminated by connecting additional miniature 0.001-μF ceramic capacitors in parallel with the existing 0.01-μF decoupling capacitors C_{16} and C_{17}. The cause of oscillation in the frequency-changer is associated with the lead from the valve screen-grid to the 4-μF smoothing capacitor C_{13} and can be cured by insertion of an additional resistor R_{22} in series with the screen-grid as shown in Fig. 1. The value of the resistor is not critical and 330 Ω has been found satisfactory.

Some correspondents have suggested the use of an EF91 valve in place of the EF95 as r.f. amplifier. This suggestion has the advantage that all the valves in the unit would then be of the same type. An EF91 can be used by adopting the slightly modified circuit given in Fig. 2. The aerial coil requires modification to allow for the lower input resistance and higher input capacitance of the EF91 and a coil of four turns spaced to occupy 0.5 in on the Aladdin former, with two turns wound over the earthy end for aerial coupling, has been found satisfactory. The copper screen separating the control-grid and anode circuits of the r.f. amplifier should be retained but, because of the different pin connections of the EF91, should be soldered to the cathode and suppressor-grid

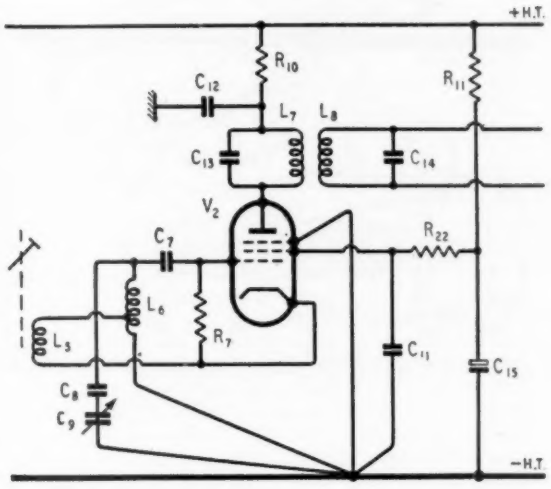


Fig. 1. Frequency-changer circuit showing the additional decoupling resistor, R_{22}, mentioned in the text in the screen-grid lead.

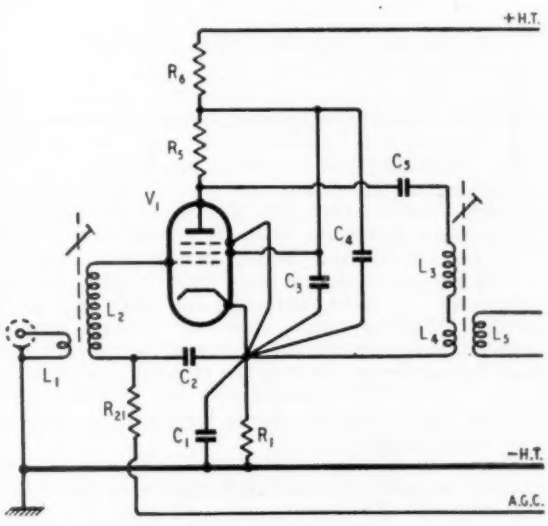


Fig. 2. The r.f. stage modified for use of the EF91 valve.

* B.B.C. Engineering Training Department.

tags (numbers 2 and 6 respectively) and, of course, the centre spigot of the valveholder. This is illustrated in the drawing of a suggested layout in Fig. 3. To keep the copper screen in its original position with respect to the chassis, the r.f. valveholder must be rotated through an angle of approximately 45 degrees with respect to the position illustrated in the photographs of the original article. The screen-grid of the EF91, can, with advantage, be returned to the h.t. line and the screen-grid potentiometer originally used is no longer necessary. A decoupling circuit consisting of a 4.7-kΩ resistor and 0.001-μF capacitor is included in the anode and screen-grid feeds as shown in Fig. 2. No change is required in the coupling circuit between r.f. valve anode and frequency-changer grid.

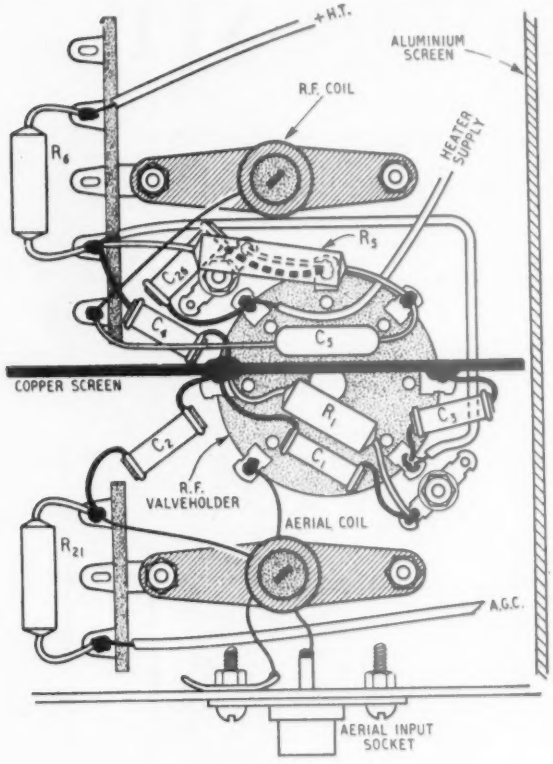


Fig. 3. Since the performance of v.h.f. equipment depends as much on the component layout as on the circuit, the actual disposition of components in the modified r.f. stage using the EF91 valve is shown here.

For weak signals giving no appreciable a.g.c. voltage, the substitution of the EF91 for the EF95 gives approximately 6 db loss in a.f. output, but where there is a good signal from Wrotham the change of valve produces no significant fall in a.f. output.

During alignment of the i.f. transformers it is sometimes found that there are two positions of the dust-iron core giving a peak in the detector output. To find the correct peak, it is advisable to start with the core well out of the winding, and remote from the coupled winding, and advance it until the first peak in output is obtained. This is the correct alignment point. If the core is advanced farther the output begins to fall due to mistuning but a second peak may be obtained due to the increase in the degree of coupling between the primary and secondary windings.

Meter Protection

Design and Performance of Fine-wire Fuses

By F. R. W. STRAFFORD,* M.I.E.E.

THE delicately constructed, but nevertheless robust, moving-coil milliammeter may be damaged permanently in two ways. An overload, in itself insufficient to burn out the coil or its leads, may damage the movement, due to the force involved when the pointer strikes the stop. A greater overload will burn out the coil and usually damage the movement.

Any protective device must include three essential properties: it must carry the full-scale current for several thousand hours, clear the heaviest overload without damaging the coil and clear the heaviest overload *before* the pointer hits the stop. It is obvous that such a device must possess very low thermal inertia in order that it should operate very quickly when the overload is applied.

Curve (a) of Fig. 1 shows the time taken for the pointer to reach full-scale deflection as a function of the overload. The instrument used in all the experiments was a 2½-in moving-coil type with 10-mA f.s.d. The shape of this curve appears to be fairly typical of various makes of the same type.

During the preparation of this curve it was ascertained that brief overloads of about 300 per cent, while causing the pointer to hit the stop somewhat vigorously, did not appear to cause damage to the movement or its balance, or to the calibration accuracy. Such an overload, *if sustained,* might damage the coil by heat. Overloads in excess of 300 per cent would probably cause damage, but experiments in that direction were not pressed home as in any event the fuse should be capable of clearing such an overload before damage occurred.

The curve (a) shows that f.s.d. is reached in about 0.1 second at rated current. At 300 per cent overload f.s.d. is reached in about 0.04 second. It is clear that a protective device must be capable of clearing this latter overload in less than 0.04 second.

Ideally, the device should clear instantly at all over-

* Belling & Lee, Ltd.

loads however small, that is, before the pointer reaches the stop; but the initial experiments indicated the latitude which could be safely introduced in practice.

It was subsequently ascertained that a very simple cartridge-type fuse employing an exceedingly fine platinum wire element would give adequate protection under all fault conditions because of its very low thermal inertia, which conduces to rapid blowing.

Wire to carry 10-mA f.s.d. current continuously, but to fuse under the prescribed overload conditions, is about one-twentieth the diameter (0.002in) of an average human hair. It is a practical impossibility to draw wire down to 0.0001in and to store it on reels.

Use is therefore made of a unique method of manufacture invented and developed by W. H. Wollaston, F.R.S. (1766-1828) who was a very close friend of P. N. Johnson, the founder of the well-known firm of assayists, refiners and fabricators of precious metals Johnson, Matthey & Co.

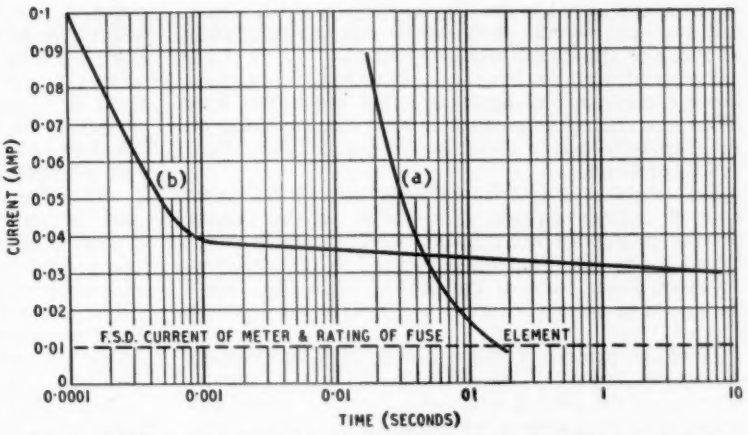


Fig. 1. (a) Time taken for pointer of a 2½-in meter to strike the stop after the application of currents in excess of the full-scale deflection current of 10 mA. (b) Blowing time of platinum fuse element as a function of current.

The technique consists of fitting a rod of platinum into a silver tube, the outer diameter of the tube being of the order of 20 times the diameter of the rod (Fig. 2). This "billet" is progressively drawn through reducing dies until the requisite final diameter of the platinum is reached. Using a factor of 20 times the composite wire has an overall diameter of 0.002in which corresponds to 47 S.W.G. and is relatively easy to handle and store. After assembly the silver is dissolved away in a weak solution of nitric acid, which does not attack the platinum, and the desired fine platinum wire remains.

The idea was developed originally for cross-sights in optical instruments, such as telescopes, and while the acid technique was satisfactory for this purpose great difficulty was encountered in applying it to fuse manufacture.

The only way of supporting such a fine wire in a standard $\frac{1}{4}$in × $\frac{1}{16}$in glass cartridge with metal end-caps was to use a short length of about 0.1in connected between two stout backing-wires supported in an insulating block (Fig. 3).

Before acid-stripping the wire it was soldered to the backing-wires at the junctions A, B. After dipping the assembly into an acid bath for sufficient time to remove the silver coating, and then neutralizing the remaining traces of acid with an alkali and finally washing, it was found that continuous corrosion took place at the soldered junctions and the connection failed or was intermittent after a few weeks.

It was subsequently ascertained that when a liquid is drawn into minute crevices by means of capillary action it is impossible to mix other liquids with it. A simple experiment was performed to demonstrate this property and the details are worth describing

A piece of transparent glass capillary tubing, as used for example in clinical thermometers, is touched into a weak solution of nitric acid to which a few drops are added of pH indicator which changes colour when a solution changes from acid to alkaline—a process which may be reversed many times. Bromothymol blue was used in this experiment; the colour is orange in an acid solution and changes to deep blue when the solution is made alkaline. It is very sensitive so that the solution need only be very weakly acidic or alkaline for the change to take place.

When the capillary tube is touched into the acid solution the orange-coloured fluid rises immediately and fills the bore, and can be seen against a white background. The end of the tube is now touched into a solution of ammonia (which is strongly alkaline). It will be noticed that the column of acid is only neutralized for a short distance along the bore as shown by a deep blue coloration. There is a clear boundary between the blue (alkali) and the orange (acid) and the tube may be sealed and kept for many months without any diffusion of the one fluid into the other.

This is the explanation as to why the acid continues its action in the minute capillaries formed in the process of soldering the junctions of the element and is not neutralized by the subsequent alkaline treatment. A wax or other protective coating is useless because a capillary still exists where the wire enters it.

A new method of approach was attempted by making use of a phenomenon well known in electroplating. The electrodeposition of one metal upon another consists of immersing the object to be coated into a solution containing, as an essential ingredient,

Fig. 2. Silver-platinum "billet" which is the first stage in the production of Wollaston wire.

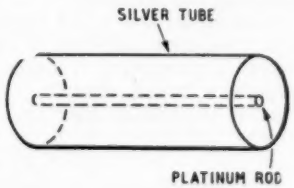
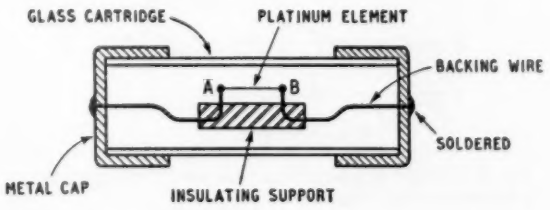


Fig. 3. Experimental 10-mA fuse employing Wollaston wire.



a dissolved salt of the metal to be deposited. The object is connected to the negative pole of a d.c. source and the positive pole to an anode comprising a plate or block of the metal to be deposited.

Presumably all readers are familiar with this general process but may not appreciate that difficulties arise when one attempts to secure an even electroplating on an irregularly shaped object containing hollows, sharp bends, or bores.

For example, it is difficult to electroplate the inner bore of contact sockets. The ability of the plating process to deposit metal in inaccessible places is referred to as the "throwing power" of the process. In short, those parts of the object which can "see" the anode in an optical sense will receive the heaviest deposit.

Now the process of electroplating may be reversed merely by reversing the polarity of the d.c. source, whereupon the plating is stripped from the object and returned to the parent anode (now the cathode). From this it follows that it is just as difficult to *extract* metal from a hollow, or a bore, as it is to deposit it.

This observation led to the development of a low-rating cartridge fuse using Wollaston wire as the element, in which the silver coating is removed by electro-stripping, and the stripping is confined to a small central portion of the wire purely by making use of the "throwing" phenomenon.[1]

Fig. 4 shows a section of the assembled fuse. The cartridge is constructed from a ceramic tube of very small bore with a central cross-hole or window and is fitted with the usual metal end-caps. The coated Wollaston wire is threaded through the bore with a very fine needle and soldered to the caps.

At this stage the assembly is connected to the positive pole of a d.c. source and is suspended in an ammoniacal solution of silver-nitrate in which is also suspended a silver cathode connected to the negative pole. The silver on that part of the Wollaston wire crossing the window is stripped so rapidly that by the time it is completely removed there has been negligible action upon that portion of the wire remaining in the narrow bore of the ceramic cartridge.

Due to the neutral behaviour of the remaining traces of ammonium-nitrate after drying there is no corrosive action, so that one is left with a robust fuse capable of being mass produced and in which the length of platinum element is controlled by the diameter of the window. These latter characteristics determine the resistance of the fuse and the prospective current which it can clear without maintaining an arc or shattering the cartridge.

Fuses based upon this method of construction, and with a window diameter of approximately 0.1in, will possess a minimum resistance of approximately 40 ohms for a 10-mA rating.

So far the ratings have been restricted to the range 10 to 25 mA. While it is a simple matter to extend the range in the higher direction great difficulties arise when attempts are made to obtain ratings less than 10-mA. The platinum wire when stripped becomes so fragile that the lightest air draught is sufficient to break it. There is also some difficulty in drawing a composite billet down to final platinum diameters of less than 1/10,000in.

It is appreciated that there are certain applications in which the resistance of the fuse will affect the ultimate calibration of the instrument. In this event it is wise to include a small pre-set resistance with the fuse so that the circuit can be adjusted to the correct calibration when a fuse has to be replaced.

The normal application of milliammeters is such that a series resistance of 40 ohms ±, say, 25 per cent, can be tolerated without affecting other parts of the circuit.

Curve (b), Fig. 1, depicts the blowing time as a function of current of a typical 10-mA rating. It is at once apparent that, for overloads in excess of 300 per cent, the fuse blows long before the needle can reach f.s.d. In fact, the accompanying table shows that moderate overloads cause the fuse to blow before the needle has a chance to move more than a few divisions. For example, on a 300 per cent overload (i.e., 0.04A) the fuse blows in less than one-thousandth of a second, whereas it takes 0.04 sec for the pointer to reach f.s.d.

TABLE

Percentage Overload	Percentage F.S.D.	
5,000	0.2	
2,500	0.3	
750	0.5	
500	1.0	
250	2.0	
200	4.0	
150	50.0 to 100	Critical region
125	Greater than 100	
100	„ „ 100	
0	Exactly 100	

There is a certain critical overload condition at which the fuse blows just as the needle reaches f.s.d. but, as pointed out earlier, at this overload and at lower overloads which enable the pointer to "hold" against the stop continuously, the amount is insufficient to damage either the coil or its associated mechanism.

The conclusion to be reached is that simple cartridge-type fuses containing an element of fine wire, preferably platinum on account of its indefinite life under normal conditions, can successfully protect the popular type of moving-coil milliammeter over a wide range of overload conditions. Connection can even be made to the 240 volts mains supply, at the consumer's outlet socket, without damage to the meter, and with a clean rupture of the fuse element.

The critical range over which there may be some possible damage to the movement of the meter is between 100 and 150 per cent overload although no damage was caused during the tests.

Even if occasional damage were to result, the statistical probability of a fault providing an overload of between 100 and 150 per cent, when there is such a very large range to embrace, is extremely low and might require the existence of many hundreds of random faults before the condition was met.

[1] U.K Patent No. 647049.

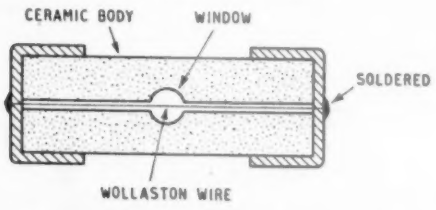


Fig. 4. Section of fuse in which the wire is prepared by an electro-stripping process.

Simple Capacitance Checker

Resonance Method Using Grid Dip Oscillator Circuit

By T. R. SMITH*

THIS apparatus was built to provide a simple means of checking the values of small capacitors and the minimum and maximum values of variable capacitors and trimmers. Further uses would no doubt be found in practice.

In operation the device is similar to a grid dip oscillator except that the frequency is fixed (see Fig. 1). Permanently coupled to the oscillator is a variable tuned circuit which, when tuned to resonance, will cause a drop in grid current. A Colpitts type oscillator is used, as the most easily obtainable coils are of the two-terminal type. The range of the instrument is determined by the maximum value of C_1 and, as the inductance of L_1 equals that of L_2, C_1 also fixes the series capacitance of C_4 and C_5. These values are also, of course, dependent upon the L/C ratio required to give satisfactory oscillation.

If an unknown capacitor is now connected at C_x, C_1 will have to be reduced in capacitance to bring the circuit back to resonance. The amount by which it is reduced will be equal to the value of the unknown capacitor. Thus if C_1 has a calibrated dial it is possible to read directly the value of the unknown capacitor. In practice this is made easier by the addition of a small capacitor C_2 as shown in the complete circuit diagram Fig. 2.

Adjusting the Circuit

The components may be arranged in any convenient manner, care being taken to keep the wiring rigid in the tuned circuits. The position of L_1 relative to L_2, however, is important and it should be adjusted so that the dip in grid current is just discernible when C_1 is tuned through resonance. The coils should then be fixed securely in this position and mounted rigidly. The amount of grid current flowing through the meter can be adjusted by varying the value of R_1, a convenient deflection being approximately half scale.

The component values quoted will be suitable for most small triodes, but as individual coils differ variation in the resistance of R_1 and R_2 may be necessary to obtain satisfactory oscillation.

The power requirements are quite small, and although a conventional power supply could be used the arrangement shown works quite well in practice. Care must of course be taken to ensure that the neutral line of the mains supply is always connected to chassis. As a further precaution the unit might be housed in an insulated box.

Method of Calibration

Calibration is carried out as follows. C_1 and C_2 are set to maximum capacitance and both dials marked "0." C_3 is then adjusted for minimum grid current on the meter. A close-tolerance capacitor of 50 pF is then connected at C_x and, with C_2 left at "0," C_1 is adjusted for minimum grid current. This point on the dial of C_1 is marked "50." Further capacitors are now connected at C_x so that calibration points at 50-pF intervals can be marked. This procedure is continued until the minimum capacitance of C_1 is reached. Close-tolerance capacitors of the correct values can be used, e.g., 50, 100, 150, 200 pF, etc., or 50-pF capacitors can be added together to give the required value, although this last-mentioned method may introduce a slight error compared with the first. Capacitor C_2 is treated in a similar manner, except that its dial is calibrated at 10-pF intervals.

An alternative method of calibration, using only one close-tolerance 50-pF capacitor, is as follows. Connect the 50-pF capacitor at C_x and adjust C_1 for mini-

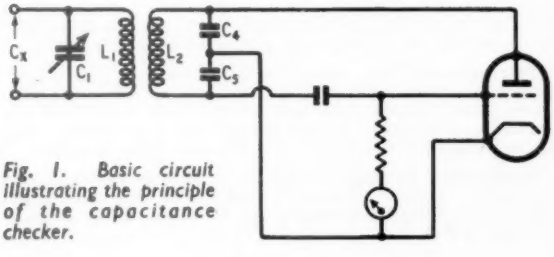


Fig. 1. Basic circuit illustrating the principle of the capacitance checker.

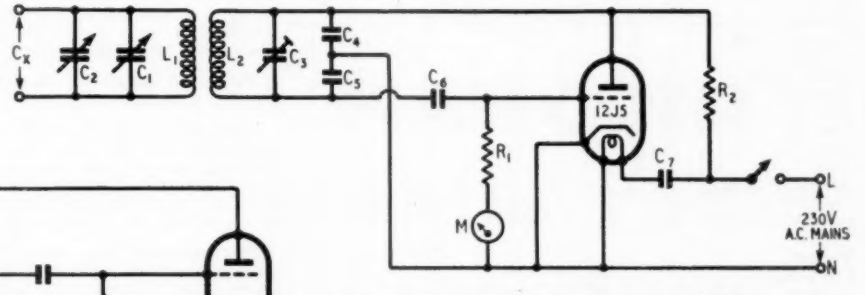


Fig. 2. Complete circuit diagram. C_1 = 500pF, C_2 = 60pF, C_3 = 100pF, C_4 and C_5 = 1,000pF, C_6 = 300pF, C_7 = 2μF 400V working, R_1 = 47kΩ ½W, R_2 = 20kΩ ½W, L_1 and L_2 = 2,000μH approx. (long-wave coils), M = 500μA f.s.d.

* Amateur radio station G3BMN.

mum grid current, marking the dial "50" as before. Remove the 50-pF capacitor and, leaving C_1 at its new position, connect at C_x a variable capacitor (preferably 500 pF) which is then adjusted to give mimimum grid current again. Reconnect the 50-pF capacitor across both C_x and the variable capacitor and reset C_1 for minimum grid current. The dial of C_1 is now marked "100." This procedure can be continued up the scale of C_1 until its minimum capacitance is reached. Calibration of C_2 is done in a similar manner, using a 10-pF close-tolerance capacitor and a variable capacitor of 50 pF.

In all cases the calibrating capacitors should be connected directly to the terminals C_x, so that maximum accuracy is obtained.

With the component values given the instrument will read up to a maximum capacitance of 500 pF in calibrated steps of 10 pF with sufficient accuracy for general requirements.

STOCKHOLM V.H.F. PLAN

WHEN summarizing in our October issue the plans for European v.h.f. broadcasting drawn up at the Stockholm Conference, we gave the number of frequencies assigned to this country, but did not draw any comparison with assignments to other countries. In a recent issue of its *Bulletin*, the International Broadcasting Organization (O.I.R.) published a critical review of the Conference in which is included a tabulated summary of frequency allocations, the essential details of which are given herewith.

The number of v.h.f. assignments—both television and sound broadcasting—provided for in the Stockholm plans are given in the last two columns and in the preceding two columns the number of stations for which each country made request. Although not directly related to the v.h.f. plans, the number of frequencies in the medium- and long-wave bands allocated at Copenhagen are given in the first column.

Countries	Copenhagen Plan	Countries' V.H.F. Requirements		Stockholm V.H.F. Plan	
		Television	Broadcasting	Television	Broadcasting
Albania ..	4	5	11	4	11
Austria ..	4	7	24	9	28
Belgium ..	4	5	22	4	25
Bielorussia	4	15	28	8	33
Bulgaria ..	4	11	24	7	23
Cyprus ..	—	—	—	—	1
Czechoslovakia	8	15	35	9	37
Denmark ..	3	—	—	8	41
Eire ..	2	—	—	5	10
Finland ..	7	7	54	14	58
France ..	18	45	183	50	178
Germany, East	3	9	38	6	22
Germany, West	6	33	95	27	246
Great Britain	13	36	118	40	189*
Greece ..	7	—	—	—	—
Hungary ..	4	15	34	8	35
Italy	11	9	18	15	188
Luxembourg	1	2	2	1	2
Malta ..	—	—	—	—	1
Monaco ..	1	2	3	2	3
Morocco and Tunis ..	8	5	—	5	—
Netherlands	2	5	20	4	25
Norway ..	12	—	—	34	124
Poland ..	9	23	57	24	75
Portugal ..	10	—	—	—	—
Rumania ..	6	18	40	11	40
Saar ..	1	2	3	1	3
Spain ..	9	4	6	21	81
Sweden ..	12	—	—	50	101
Switzerland ..	4	9	20	13	39
Trieste ..	—	—	—	2	4
Turkey ..	4	—	—	43	87
U.S.S.R.† ..	24	100	183	76	187
Ukraine ..	10	52	94	33	90
Vatican City	1	2	2	2	2
Yugoslavia	8	16	—	22	88

* This figure includes the alternative assignments prepared for the U.K. providing for 110 a.m. stations or 79 f.m. stations.
† Territory West of the meridian 40° East

MANUFACTURERS' LITERATURE

Moving-coil Headphones, available as single earpiece, single headset or double headset, with impedance of 25Ω per earpiece. Leaflet describing construction and giving specification and response characteristic over 50 c/s-10 kc/s, from Standard Telephones and Cables, Transmission Division, North Woolwich, London, E.16.

Moulded Terminal Blocks; two-, three- and four-way connectors and twelve-way strips which can be cut up, all with nickel-plated brass terminals. Leaflet giving sizes and prices from Precision Components (Barnet), 13, Byng Road, Barnet, Herts.

Tape Unit, the Truvox Mark III, with three-motor drive, drop-in tape loading, push-button control and two speeds. Main features described briefly in a leaflet from Truvox, Exhibition Grounds, Wembley, Middlesex.

Components and Accessories; a 1953 catalogue from Watts Radio (Weybridge), 8, Baker Street, Weybridge, Surrey.

Chassis Fittings; developments and improvements described in No. 1 series leaflet (to go in catalogue folder) from A. F. Bulgin & Co., Bye-Pass Road, Barking, Essex.

Electrical Resistance Materials; a well-produced and illustrated new edition of booklet 1440, giving information on the principal base metal resistance alloys and on materials for specialized purposes. Tables give resistance per unit length for nominal diameters and percentage tolerances. From Johnson, Matthey & Co., 78-83, Hatton Gardens, London, E.C.1.

Export Table Radiogram, Ekco type TRG189, plays automatically all sizes of standard and long-playing records, covers medium and short wavebands in three ranges and is fed from 100/150 V or 200/250 V a.c. mains. Brief specification on a leaflet from E. K. Cole, Southend-on-Sea, Essex.

Components, Accessories and Test Gear; a very comprehensive indexed catalogue containing about 5,000 items from Arlt Radio Versand (Arlt Radio Export Company), Walter Arlt, Berlin-Charlottenburg 1, Kaiser-Friedrich-Str. 18, price 1 mark.

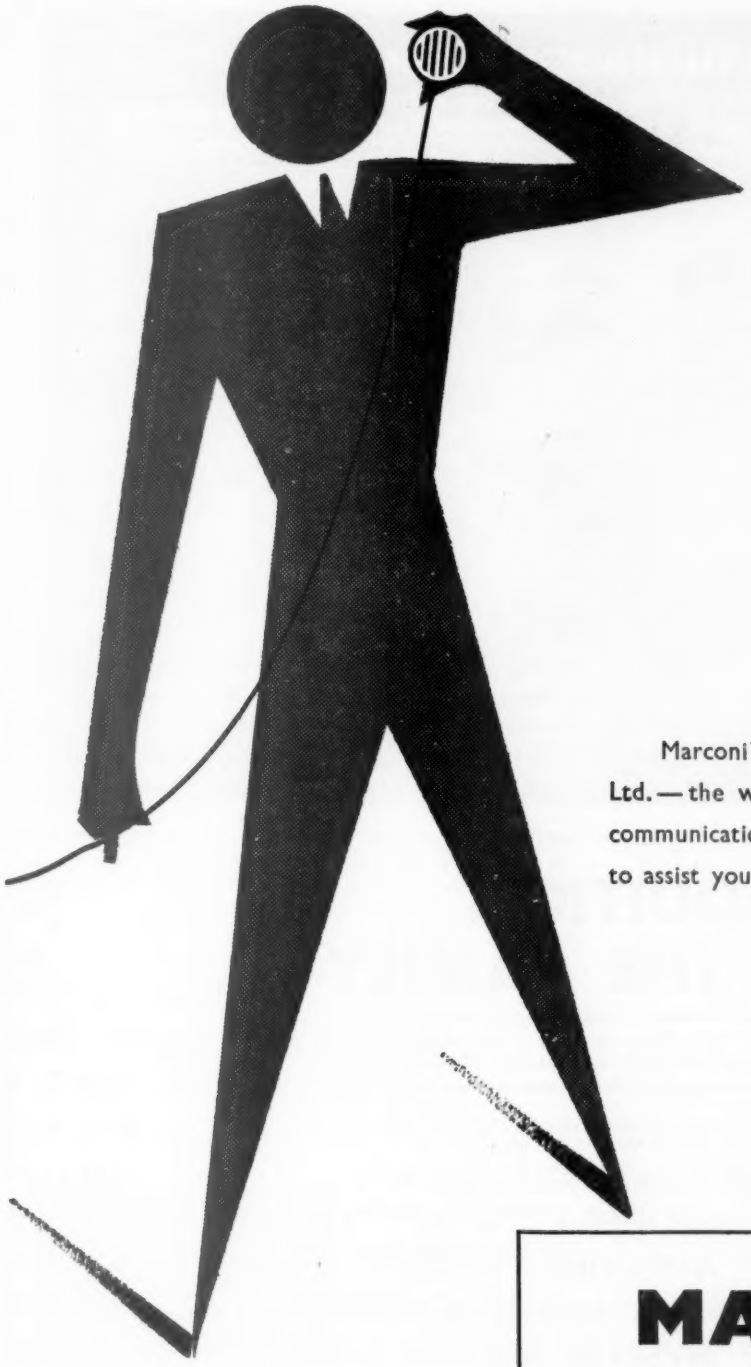
Portable Test Set for overall checking of v.h.f. multi-channel communications equipment as used in civil aircraft. Receiver sensitivity, transmitter output, modulation depth, etc., can be checked by a single engineer. Descriptive leaflet from Radio-Aid, 29, Market Street, Watford, Herts.

Television Aerials; a catalogue from A.B. Metal Products, 16, Berkeley Street, London, W.1.

Capacitors; a guide booklet giving information on standard forms of cases available and the capacitances and voltages they will accommodate for various ranges of working temperature. From Standard Telephones and Cables, Telephone Line Division, North Woolwich, London, E.16. Also a broadsheet on capacitors for marine radio interference suppression.

Electroplating Set, using flashlight batteries in a self-contained plating tool with a brush anode. Jars of gold, silver, nickel. copper, tin and zinc plating compound are provided. Descriptive leaflets from Scope Laboratories, 417, Keilor Road, North Essendon, Melbourne, W.5, Australia.

Horizontally Polarized Television Aerials for Pontop Pike and Belfast stations. Illustrated price list showing types available, from Wolsey Television, 75, Gresham Road, Brixton, London, S.W.9.



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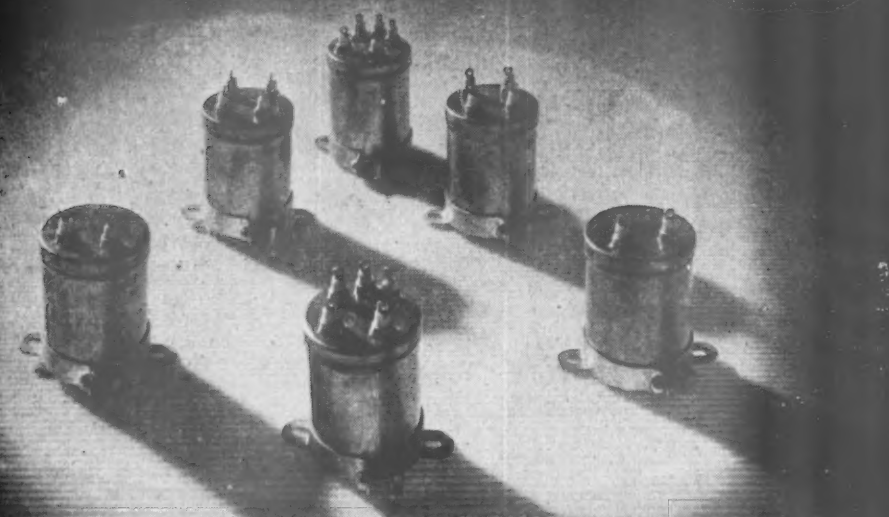

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Storage Cathode-Ray Tube

By L. S. ALLARD* B.Sc., A.Inst.P.

Electrostatic "Memory" System for Digital Computing Machines

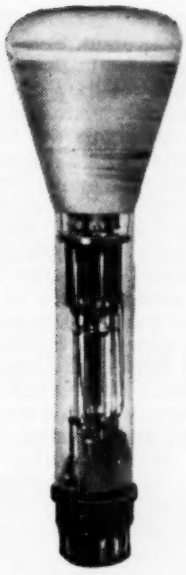


Fig. 1. The storage tube looks very much like an ordinary oscilloscope cathode ray tube.

DIGITAL computors need some form of storage mechanism to enable solutions of problems and instructions concerning succeeding operations to be retained. There are various means by which this can be achieved, including mercury delay lines, magnetic recording and electrical charge storage on an insulated surface. The last-named method was chosen for the digital computor now in use at Manchester University† and, in particular, cathode ray tubes were used as the storage medium.

The initial hopes of using ordinary commercially made cathode ray tubes as the storage medium did not materialize. When tried, such tubes were found to have two main defects: (a) random spurious pulses over the screen area (known as "phoneys"), and (b) small total storage capacity. A special tube, shown in Fig. 1, was therefore developed at the G.E.C. Research Laboratories to overcome these disadvantages. This is an electrostatic-deflection tube incorporating an electrostatically focused gun to give a very small spot and a fluorescent-screen storage surface.

In operation, the computor uses the binary scale and the two digits 0 and 1 are represented by charge distributions on the storage surface.‡ These different charge distributions can be established by various techniques, for example, by the spot being either defocused or focused, commonly known as defocus-focus, or by the focused spot being drawn out into a small line, known as the dot-dash system. Although the last-mentioned system was used originally, the reliability of the storage surface was impaired if there were any "phoneys" of amplitude greater than 50 per cent of the initial pulse at the beginning of the trace. The defocus-focus system is now used, and with this it is possible to operate a tube having a much larger amplitude of "phoney" signal.

The display of these binary digits can be seen on the face of the storage tube since the electron beam is intensity modulated as it scans over a rectangular raster. A dot pattern is thus produced, a typical pattern consisting of 64 rows of 32 dots per row.

As the beam scans over the previously deposited charges on the storage surface, current waveforms are capacitively induced in a "pick-up" plate which is fixed to the outside surface of the storage tube screen. These waveforms are shown in Fig. 2. By strobing, or selecting a particular portion of these waveforms, as in Fig. 2, positive and negative pulses can be made to represent the two binary digits.

To overcome any leakage defects of the fluorescent screen, it is necessary to regenerate the charge pattern at a frequency greater than 5 cycles per second. This is achieved by allowing the amplified output pulses to control the voltage waveforms applied to the modulator and focusing electrodes, while the beam is being scanned. By this means, the information inserted into the storage system can be maintained indefinitely. When the information is required for some other part of a calculation in the computor, the amplified output pulses can be re-routed to the appropriate circuits. It is customary to regenerate and abstract the necessary digits on alternate scans.

The presence of a "phoney" is indicated by a negative signal in the output lead at some random position on the storage surface. If the amplitude of this signal is too large it may be impossible to obtain a positive signal at this particular position during storage, and the tube is therefore unreliable.

It was originally considered that "phoneys" were

† "New Digital Computor," *Wireless World*, August, 1951, p. 333.

‡ Williams, F. C., and Kilburn, J., "A Storage System for Use with Binary Digital Computing Machines, *Proc. I.E.E.*, Part III, No. 40 (March, 1949).

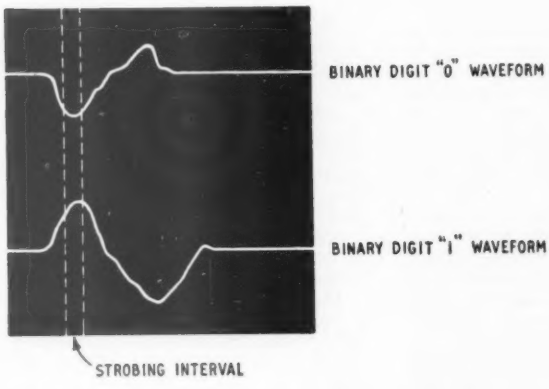


Fig. 2. Showing how positive and negative pulses are strobed to represent binary digits.

* Research Laboratories of The General Electric Company.

due to two factors: (a) particles of carbon from the internal conductive coating settling on the screen, and (b) pinholes in the screen allowing the electron beam to bombard the glass, which has a different secondary emission coefficient from that of the screen. The first of these factors was eliminated by using silver instead of graphite as the internal conductive coating, but the second was shown by experiment to be unconnected with the occurrence of "phoneys." The removal of these "phoneys" has been finally achieved by extremely careful preparation of the phosphor, and by absolute cleanliness while the screen is being deposited and until the bulb with its electrode system is sealed to the pump for evacuation.

In view of the difficulties encountered in preparing good screens, the possibility was considered of using insulated surfaces other than fluorescent powders, but no large-scale investigation into their preparation was made. Although such surfaces, produced by evaporation, would probably have yielded more uniform results, this advantage was outweighed by the desirable property of tubes with fluorescent screens acting as their own monitors and giving a bright display on the screen.

Atmospheric conditions, e.g., humidity, have been known to affect the operation of the tubes if they have been made of low-resistivity glass, such as soda glass. For this reason, high-resistivity lead glass is now used exclusively for the bulbs.

To improve the total storage capacity of the tube it was necessary to reduce the tube spot size. The main methods of achieving this were either to increase the tube e.h.t. or to redesign the electron gun to give an inherently smaller spot without increasing the tube e.h.t. Either of these methods has the effect of increasing the amplitude of any "phoneys" present. An increase in e.h.t., however, would also entail an increase in the voltage required to deflect the beam, so that the redesign of the electron gun was chosen as the best solution. A pentode electron gun is used, the first accelerating anode and second anode (focusing electrode) taking no current, while a small aperture in the final anode allows only a small fraction of the current leaving the cathode to arrive at the screen. The spot size in the redesigned tube operating at 1kV is about 0.3 mm, and approximately 2,000 digits have been stored on the tube face.

The cathode emission life in these tubes should be no worse than in standard commercial oscilloscope tubes. The rate of deterioration of the storage surface under typical operating conditions has not yet been accurately determined but information on this is being obtained from the behaviour of tubes in the Manchester University computor.

Manufacturers' Products

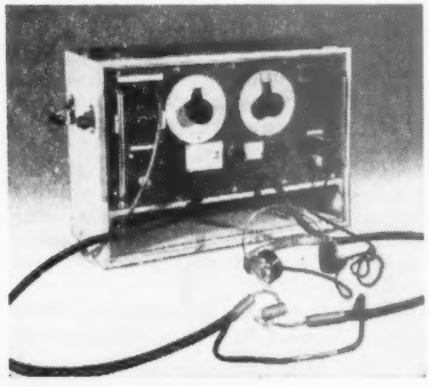
NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

"*In-Situ*" *Impedance Bridge*

THIS bridge is intended for measuring resistance and capacitance between 1Ω and 10,000 MΩ and 0.1 pF and 1,000 μF respectively. It is an a.c. energized bridge with measurements made at 1,592 c/s, a frequency which, with the circuit employed, gives equal sensitivities on the separate resistance and capacitance dials.

Transformers are used for the ratio arms and an important feature of the bridge is that under most conditions it is possible to measure a component without disconnecting it from adjacent wiring, even though other impedances may be connected in parallel with it. Hence the emphasis in its title on the "in-situ" feature.

E.M.I. Sales and Service "In-situ" impedance bridge Type QD215.



When measuring resistance or capacitance alone the dial not in use should be set to zero capacitance or infinite resistance as appropriate, otherwise it may be impossible to find a balance. Balance, incidentally, is indicated by a null in the tone audible in the headphones. With mixed quantities balance on both dials must be effected.

The full range of resistance and capacitance covered by the bridge is divided into nine bands each covering one decade nominally.

Since the first capacitance range is 0.1 pF nominal, the bridge can be used for measuring inter-electrode capacitance in certain types of valve.

The bridge can be operated on an a.c. mains supply or on batteries as required. It contains four valves, two each in the tone generator and the balance detector circuit. Known as the Impedance Bridge (In situ) Type QD215, it is made by E.M.I. Sales and Service, Ltd., Hayes, Middlesex, and the price is £218.

High Temperature Solder

A NEW solder consisting of a tin/lead/silver alloy having a melting point of 296 deg C has been introduced by Multicore Solders for use where unusually high working temperatures may be encountered. Known as Comsol this new alloy has been produced with the cooperation of Johnson Matthey of Hatton Garden, London and as a solder is made in wire of No. 16 s.w.g. with the customary triple core of non-corrosive flux which characterizes this particular make of solder.

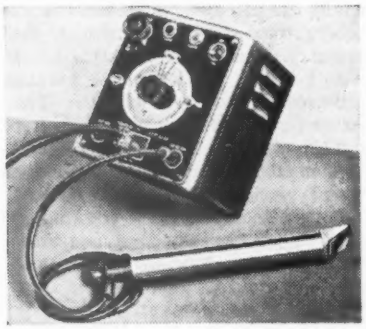
Despite the high melting point it is said that a soldering iron can be used if the bit temperature is maintained in the region of 350 to 400 deg C.

It is thought that Comsol solder may be particularly suitable for equipment subjected also to sub-zero

temperatures and investigation into this aspect of its use is at present proceeding.

Laboratory Temperature Controller

THE rapid change of phase occurring in an a.c. bridge network at the point of balance is used to give a very quick response in a new electronic instrument for controlling the temperature of water or oil baths. The instrument works on the themostat principle, with a temperature-sensitive resistor to respond to



Mullard temperature controller showing the probe unit containing the temperature-sensitive resistor.

changes of temperature in the bath and a heater to make appropriate corrections to keep the temperature constant. The resistor forms one arm of a 50-c/s a.c. bridge, the output of which is amplified and compared with a reference phase in a phase-sensitive rectifier. In this way the phase changes produced by temperature variations in the bath are arranged to operate a relay, which switches the heater on or off as appropriate. According to the makers, the temperature can be controlled to within $\pm 0.02^{\circ}$C of the working point.

By changing the value of the resistors in the "standard" arm of the bridge, the working point of the instrument can be set anywhere within the temperature range 15-75°C. This is done by a four-position range switch. Fine adjustments of the setting are made by a potentiometer control. The overall range can be extended to as low as -50°C or as high as $+80^{\circ}$C by using external "standard" resistors in place of the built-in ones.

The makers are Mullard, of Century House, Shaftesbury Avenue, London, W.C.2.

Midget Loudspeaker

THE Elac 3½-in speaker, Type 3/13, is of a kind suitable for many special applications, and seems particularly well suited for use in a communications receiver when space is limited. The magnet is exceptionally large for so small a speaker; it is of Ticonal alloy, and weighs nearly 2½ oz. It provides a flux density of 9,500 gauss.

Midget loudspeakers are not necessarily less sensitive than the larger models at medium and high frequencies; indeed, the reverse can be the case, but their small physical size does impose a limit to the audio output obtainable at the low frequencies without distressing signs of overload.

This model will handle 1 watt, but its high sensitivity gives the impression that a much more powerful speaker is being used. As it is intended primarily for speech circuits the main acoustic output is in the 300- to 3,000-c/s range. There is a tendency to favour the higher speech frequencies, but for communications work this is not necessarily a disadvantage as it enables a little more i.f. selectivity than usual to be used without producing "woolly" speech.

The model used has a speech coil impedance of 3 ohms, but 15-ohm models are available also. No output transformer is fitted.

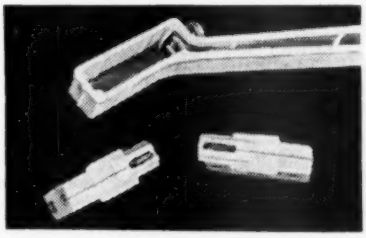
The price of the speaker is 24s 4d including purchase tax and a multi-range output transformer costs 6s 6d. The makers are Electro Acoustic Industries, Ltd., Stamford Works, Broad Lane, Tottenham, London, N.15.

Crystal Pickup

A NEAT combined clamp and contact device ensures rigidity in the mounting of the interchangeable heads used in Ronette "Miniweight" pickups, now distributed in this country by E. & G. Distributions Corporation, Ltd., 33, Tottenham Court Road, London, W.1. In types N50/3 and L50/3 for 78- and 33⅓-r.p.m. records respectively a frequency response up to 7,000 c/s is provided and the price of the arm and two heads is £4 19s 6d. For those with facilities for using a wider frequency range the N50/4 and L50/4 are available at £5 19s 6d with a response up to 14,000 c/s.

Standard and long-playing stylus radii are 0.0025 and 0.001in respectively and the weight on the point is 7.5 gm in both cases. The effective mass at 1,000 c/s is 40 milligrams.

Ronette "Miniweight" crystal pickup with frequency response up to 14,000 c/s.



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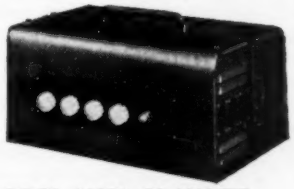

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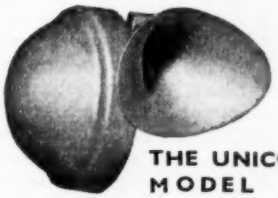

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RANDOM RADIATIONS

By "DIALLIST"

It's an Ill Wind . . .

THERE ARE FEW more interesting achievements than the turning to good account of effects previously regarded as nuisances. One well-known instance is the harnessing of the Miller Effect to do good work in the Miller capacitance reactor valve. Another, even more striking, has been brought to my thrilled ears by a young friend, who recently returned from visiting many of the oil centres of the vast tract which, for some queer reason, we now call the Middle East. A large part of the present region, including Turkey, the Levant and Egypt, used to be the Near East: if they're lumped into "middle," where is the Near East now? Anyhow, the news that interested me came from the Persian Gulf—and that is Middle East beyond all disputing. All wireless folk have theoretical knowledge and bitter practical experience of the evils caused by the polarization of primary cells. Can you think of any effect less likely to be induced to turn over a new leaf and to give useful service? Yet, that is just what has been done with primary cell polarization.

Cathodic Protection

At the oil ports of the Gulf great new jetties have been built and are still building. The material used is steel, which doesn't seem, at first flush, ideal for standing up to the chemical attacks of the warm salt water of the Gulf. Nor would it be, unless something were done about it. That "something" is to make the steel of the jetty the cathode or positive electrode of an enormous primary cell, of which the sea-water is the electrolyte. The anode of this huge cell consists of great chunks of aluminium, which is electro-negative to iron. By providing an external circuit with the right load resistance the cell can be kept permanently in a very high state of polarization, due to the maintenance of a "blanket" of hydrogen bubbles all over the surface of the steel. Consisting as they do of masses of neutral hydrogen molecules, the bubbles give almost complete protection from the effects of chemical action: any hydrogen atom which decides to abandon staid neutrality and to become an active positive ion is re-neutralized by the arrival of an electron from the cathode. The system has one interesting, if rather pathetic, by-product. All round the jetties are masses of motionless fish, all lying facing the anodes. Fish cannot help placing themselves parallel with the lines of force of an electric field which exceeds a certain strength; and they are compelled irresistibly to move away from the cathode.

The Gas Blowlamp

YOU MAY, OR MAY NOT, know the small gas blowlamp, several types of which are in the tool shops now. If you do, you will probably agree with me that, consciously or unconsciously, you have been led by hardy combination of cored solder and small, intensely hot flame to make more and more use of the blowlamp and less and less of the soldering iron. There are some jobs for which an iron is the only thing: you can't, for example, risk letting a flame play about when you're engaged in soldering wiring joints in radio, television or other electronic equipment containing components that are only too easily damaged by heat. Again, there are jobs, such as the tinning of a fairly large surface, for which it is often convenient to use both tools: the lamp supplies the extra heat needed, while the iron enables the solder to be guided over the surface. But for a very large number of sweating, jointing and seaming jobs the blowlamp is the handier and quicker tool.

Types, Uses and Possibilities

The gas blowlamps that I know are of two main types, each of which works *via* a length of ½-inch rubber tubing from a nozzle outlet in the ordinary domestic gas supply. Type No. 1 has a tubular metal body a little over ½-inch in diameter. The far end is closed by a flat disc, near the top of which is fixed a jet ⅛-inch in diameter. With no blowing, this would give a narrow yellow flame about 1½-inches long. Blowing is done automatically by drilling a small hole (No. 80 Morse drill) in the centre of the disc. Gas, issuing from this under pressure, carries air along with it and blows the flame at the orifice of the jet into a hot, blue flame, six inches or so in length. The flame of type No. 2, which has a plastic body and uses a jet based on the Bunsen principle, is smaller, though equally hot. Good as both are, I wish that, besides the standard patterns, which sell at about 4s apiece, there was available a *de luxe* model at, say, 25s. The ideal gas blowpipe is wanted on a heavy, broad-based stand that can't be upset easily; it can be clamped at any height and at any angle required.

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Most important of all, the jet is provided with a miniature gas-tap, which enables the length of the blown flame to be reduced to as little as one inch when the occasion arises. I have seen and used such *de luxe* models—in fact *I am* using one. But all these have been made in amateur workshops and I don't know of one that is obtained commercially.

Come On Chaps !

HESITATING and rather feeble legislation always seems to us a pathetic business, particularly when it is admitted on all hands that there is a wrong to be righted and that strong action is long overdue. I am thinking now, of course, of this footling business of making the fitting of suppressors compulsory only on cars delivered after the middle of the present year. Why this tomfoolery —for one can use no milder term? The P.M.G. knows that all vehicles can be suppressed—and cheaply; for all Government vehicles have been fitted with suppressors for some time. There can be no hardship in compelling an owner to spend a few shillings in suppressing a vehicle that cost hundreds of pounds. The P.M.G. can be in no doubt as to what constitutes interference, for the advisory committee told him that. Very many car and lorry owners also have television sets and stand to benefit like everyone else from strict and swift legislation. Nobody wants it to be a matter of 10 or 15 years before snowstorms on the screen and machine-gun volleys from the loudspeaker cease to furnish unwelcome television "effects." Let's stop fooling about and deal firmly with this interference business.

The Buster Box

A FRENCH FRIEND has asked me for the English equivalent of the term *boîte à claquage*, which means literally "buster box." It's the professional (and amateur) jargon name for a continuously variable high-voltage generator, used for testing the dielectrics of capacitors and the insulation of conductors to destruction. I don't know any jargon equivalent in English, though I feel that if there isn't one, there ought to be, for it's so beautifully descriptive. Not one of the many friends that I've asked has been able to help. Readers of *Wireless World* have never yet failed to supply the answer to any query put to them in these notes; so I pass the ball to them feeling sure that if we have such a term I shall hear from them.

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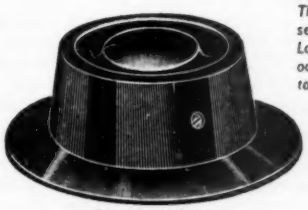
Signal-lamp fittings, Switches, Thermal Flasher Units, Micro-sensitive Switches, Mains and Low-voltage Connectors, Crocodile Clips, Valve-top Connectors, Valve Holders, Test Prods, Automobile TV Interference Suppressors, Terminals, Tag-strips, Group Boards, Resistors, Pilot Lamp Holders, Potentiometers, etc.

List No. K.324


List No. K.361

MANUFACTURERS OF RADIO AND ELECTRONIC PRODUCTS

BULGIN *Components*
A.F.BULGIN & CO.LTD
BYE-PASS ROAD BARKING
TELEPHONE Rippleway 3474 (5 lines)

UNBIASED

By FREE GRID

Shamateur Radio

THE Editor of the *B.S.W.L. Review*, which is, of course, the official organ of the British Short Wave League, gave us his views in a recent issue of his journal (Dec., 1952) on the vexed question of amateur stations. Unlike the lawn tennis authorities, who are much worried by the free racquet racket by which it is alleged certain amateur players endanger their status, he does not suspect transmitters like myself who use factory-built equipment of clandestine commercial activities.

He makes it quite clear, however, that in his personal view we are mere "shamateurs" although he does not actually say so. If I read between the lines correctly, he takes the same contemptuous view of us as his forebears of twenty years ago did of broadcast listeners, about which I protested in the issue of February 10th, 1933.

Now I am not only an amateur transmitter but also an amateur photographer of some experience and perhaps I may be permitted to draw a parallel. I doubt if a single amateur photographer of to-day uses anything but a factory-built camera, but we would be as ashamed to hand our precious negatives over to the chemist for processing as an amateur transmitter would be to hire a professional wireless operator to manipulate his gear. The aim of us photographers is not to construct our apparatus but to

Shamateur or Superman ?

make perfect our technique and eventually to produce a masterpiece which will make even Sir Alfred Munnings pulverize his palette and put out his brushes for salvage as a preliminary to buying a camera.

I cannot help feeling strongly that exactly the same argument holds good in the field of amateur radio. There is no more shame in using a factory-built transmitter than in using a commercially made camera. My own interest in amateur transmitting is quite frankly the study of wave propagation and not in exercising my mechanical ingenuity.

In my opinion the true shamateurs are those who seem to go on the air solely to discuss personal matters including their YLs and OWs with fellow OMs of similar mentality. Usually these gossip-mongers use factory-built apparatus just as I do, but the reason is not because they are interested in any scientific aspect of transmitting. Their main object, apart from gossiping, seems to be to collect QSOs, and in that respect they are rather like the seaside snapshotter who has no real interest in photography but desires only to collect soot and whitewash monstrosities of Aunt Maria paddling.

There are exceptions, of course, who can take a serious interest in the problems of amateur transmitting and at the same time give a young lady all the attention she needs. I take off my hat to them; they are men indeed.

Heading for Hitlerism ?

THE Postmaster-General does his best by pamphlet and poster to persuade wireless pirates to abandon their evil ways but he words his warnings with lamentable looseness which gives licence to lawbreakers and leaves honest men bewildered. Recently I related how his posters left me completely in the dark about the type of licence required to cover the television set which I have installed in my car for use when parked by the roadside.

Now the P.M.G. has, by another pamphlet, reminded me that I may be on the wrong side of the law with regard to the portable set in my car. I don't nowadays have a car radio fitted as there simply isn't room for it now that I have installed television. Instead I use a portable set when I want to listen to "sound-only" programmes in the car. The P.M.G.'s precious pamphlet emphasizes condition No. 7 on the back of my wireless licence by calling my attention to the fact that my home-set licence only covers the *occasional* use of a portable set in the car (the italics are mine).

Words are funny things, and I daresay many of you know the story of the very literal-minded yokel who was a member of the village choir and wished to name his newly born twins Cherubim and Seraphim because, as he explained to the astonished vicar, they "continually do cry." Like the yokel who thus placed his own interpretation on the words of the *Te Deum*, the P.M.G. may have some special, but unwarranted, meaning of the phrase he uses.

Cherubim and Seraphim ?

"Occasional use" certainly isn't the antithesis of "continuous use" as some folk think, but even if it be taken as such, I break the continuity every time I take it up to bed to enable me to hear Big Ben sound the knell of parting day, if I may misquote Gray. If the correct meaning of use "on some special occasion" (O.E.D.) be taken, is the P.M.G. to decide what is a special occasion *to me* as condition No. 7 on the wireless licence clearly implies ? If so we are indeed heading for Hitlerism, for thought-control is the very stuff of which totalitarianism is made.

Concerning St. Thomas

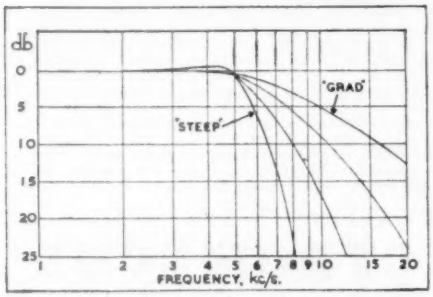
TELEPATHY can, I feel sure, be explained on a purely radio basis. It is, in my opinion, simply a matter of transmission from one brain to another of electro-magnetic waves. As long ago as June, 1946, I said in these columns that it was as much a question of extra-short waves as is rhabdomancy, concerning which D'Orsay Bell had written in an earlier edition of *W.W.* Of course, I make no claim that my idea is original for in the July, 1945, issue you will find my views anticipated by "Radiophare," a pseudonym which, as stated in the Editor's introductory note to the article, conceals the name of a radio engineer whose identity, I may add, would surprise you.

Neither Radiophare nor myself made any attempt to give the wavelength of thought and I am so far steeped in ignorance that I did not realize that it had long since been measured. In a book published over a year ago, "About Yoga," by Harvey Day, which has only just fallen into my hands, I learn that an unnamed research worker at St. Thomas's Hospital has declared that he has actually *seen* thought waves. Their wavelength was measured on a special "sensitizer" which he invented and was found to be 0.000000003 metre. I will say no more but I cannot help remembering what the patron saint of this hospital is famous for.

A RADICALLY NEW PRE-AMPLIFIER FOR LEAK 'POINT-ONE' POWER AMPLIFIERS

The

"Vari-Slope"



Frequency/amplitude curves for the "TREBLE—3" position (5 kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7 kc/s and 9 kc/s ("—2" and "—1" positions).

The filters consist essentially of twin-T resistor-capacitor networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include:—

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(b) Extremely low harmonic and intermodulation distortion due to negative voltage feedback action.

(c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control altering the terminating impedance and the insertion loss.)

(d) There are no chokes to cause magnetic hum pick-up.

(e) Smaller size, lighter weight, greater uniformity in production.

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FEEDBACK CIRCUIT DEVELOPMENT

The new "Vari-Slope" pre-amplifier has a refinement which will doubtless set the pattern for future high-fidelity reproducing amplifiers. This advance consists of variable-slope "electronic" low-pass filters operating on negative voltage feedback principles.

No Inductors ("Chokes") are used, and all their disadvantages are completely eliminated. The turnover frequencies are 5kc/s, 7kc/s, and 9kc/s and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.

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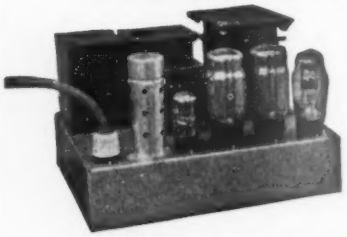

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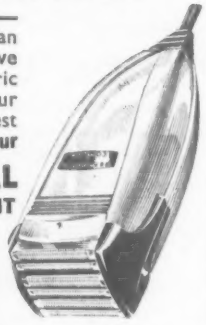

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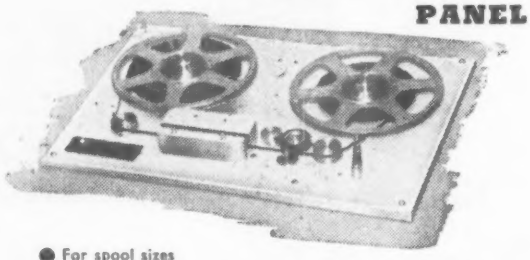

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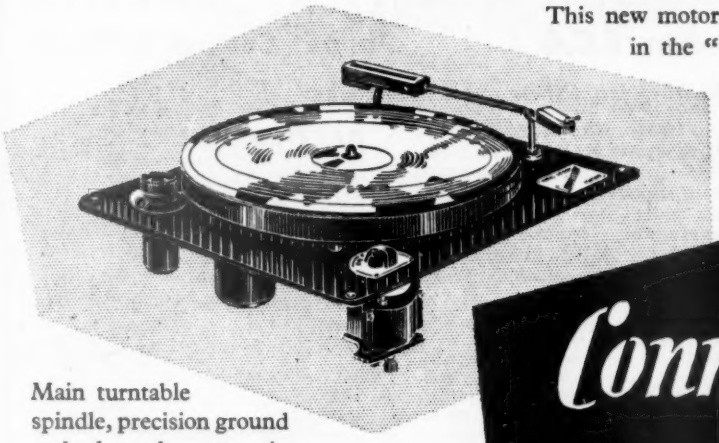

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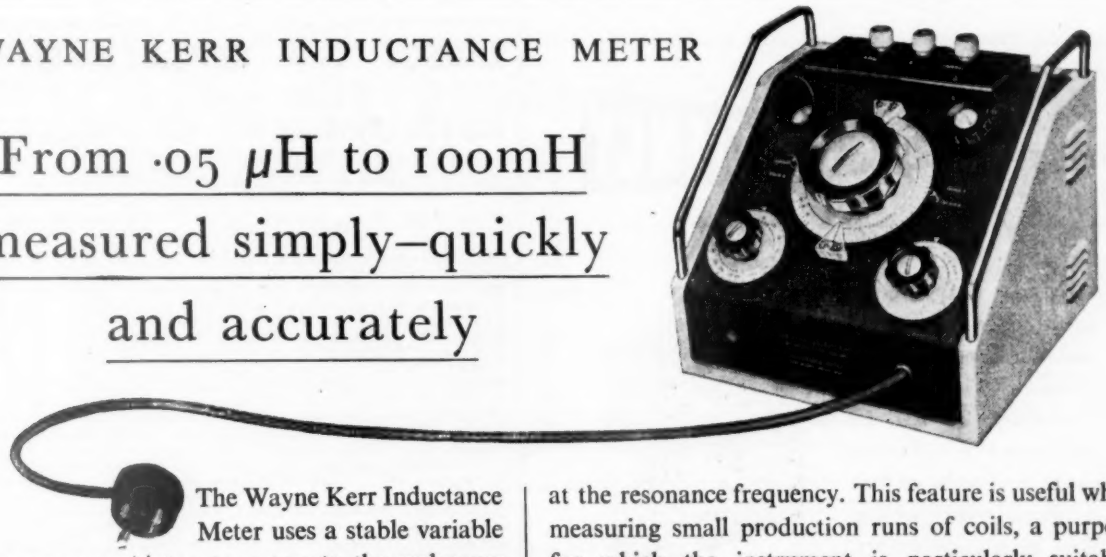

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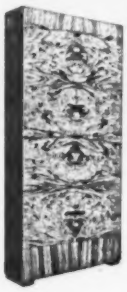

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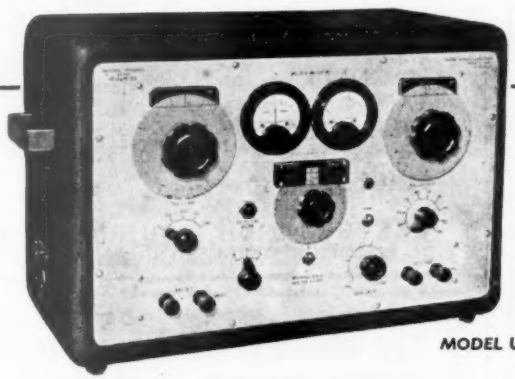

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A general-purpose instrument covering a very wide range of measurements for values of resistance, inductance and capacity. When used for resistance measurement it is connected as a Wheatstone bridge, the required D.C. source of supply and the balance-indicating micro-ammeter both being incorporated in the instrument. When used as a capacity bridge, the condenser under test is connected in a modified De Saute's Bridge. The same dial as used for resistance measurement is used to balance the capacity of the unknown condenser, whilst a second dial in combination with a decade resistance balances the power loss. For the measurement of inductance the instrument is converted into a Hay's bridge.

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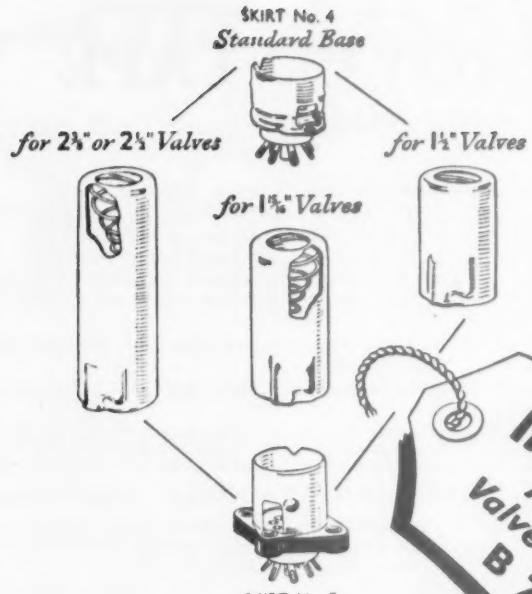

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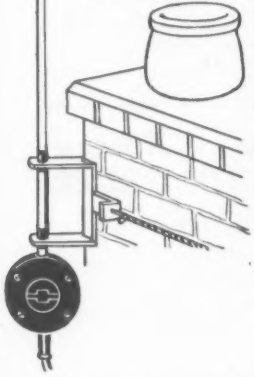

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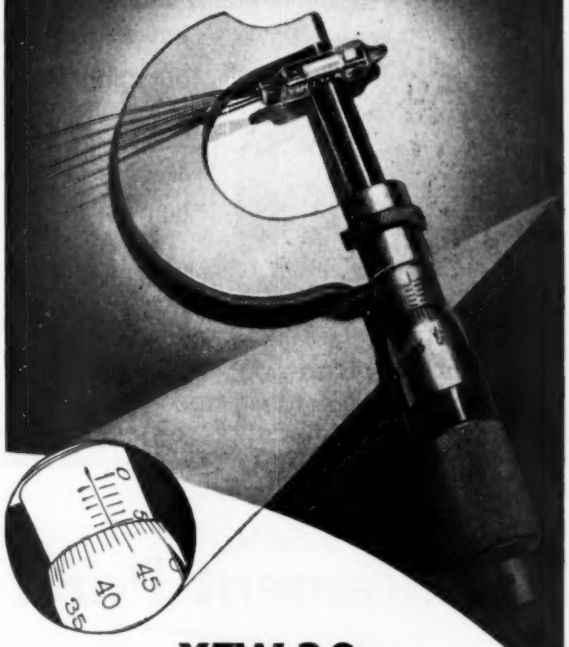

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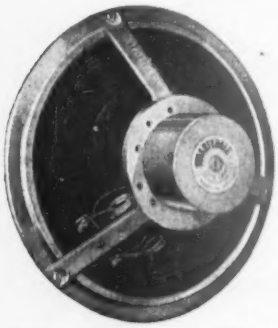

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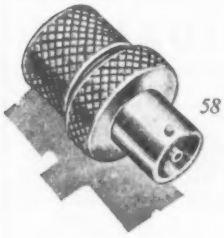
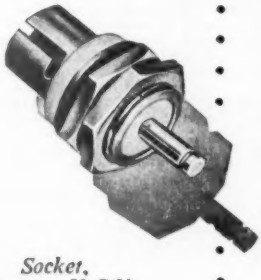


58 series plug

co-axial plugs and sockets

The connectors illustrated are designed for use with the smaller diameter R.F. cables, such as Telcon PT.1.M, PT.11.M, AS.60.M, etc. Produced for instrument designers and general application, the 58 Series Plug and Socket has a capacitance of less than 7 μμF. The 58C panel mounting socket shown will accept any plug in the 58P Series.

Panel Mounting Socket, type 58C



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Socket, type 58 S/V

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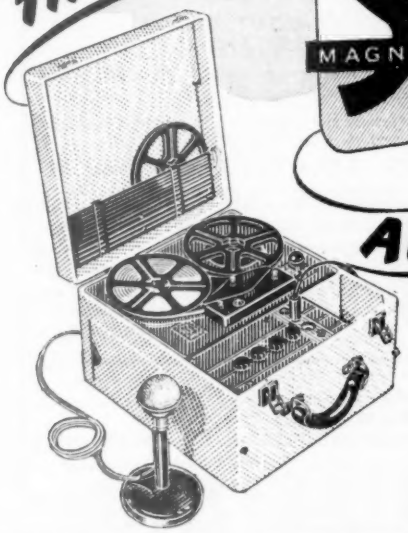

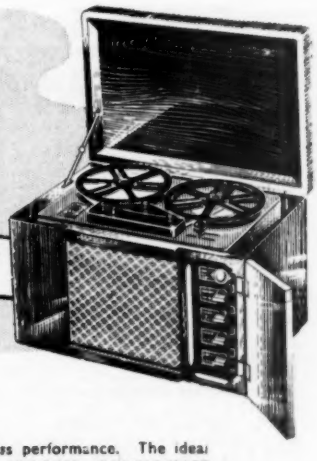

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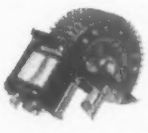

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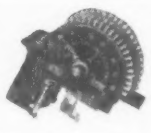

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b= *depth behind panel*
c= *depth in front of panel*
d= *overall diameter*
e= *overall height*

Output ★	Secondary Voltage	Secondary Current	No-Load Losses	DESIGN						
				Panel Mounting				Bench Mounting		
				Type No.	Dimensions mm.			Type No.	Dimensions mm.	
V.A.	V	A	W		a	b	c		d	e
260	0-260	1	6.8	84514	137	130	30	84515	137	165
520	0-260	2	9	84516	137	150	30	84517	137	185
1040	0-260	4	17	84518	187	190	30	84519	190	260
2080	0-260	8	25	84520	187	200	30	84521	215	272

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Receivers. **RCA** AR77E, 550 kc/s.-32 Mc/s., **£35.** **HALLICRAFTERS,** SX 43, **£90.** SX 24, **£35** ; SX 28, **£50.** S 20R, 550 kc/s.-42 Mc/s., **£28** ; SX 38 A.C./D.C., 110 v.-250 v., 550-30 Mc/s., **£30.** RME 69, good condition, **£40.** **HAMMARLUND,** HQ129X, NEW, **£90.** **HRO** receivers, Junior and Senior, complete, from **£30.** **RCA** AR88's, CR100, **£30.**

Manuals for RCA AR88 D-LF, HRO'S, CR100, S.27, SX 28, AR77E, S.20, **£1/7/6** per copy.

Audio Equipment.
Speakers : Vitavox, Goodmans, etc. BSR Recording Equipment. Scophony-Baird. Cine Soundmaster tape recorder, as NEW, **£50.**

In Stock.
Bendix B2 221 Frequency Meters. TS 69AP 300-1,000 Mc/s., Wavemeters. **Marconi** Signal Generator TF 517-390G, TF 144G. **Lavoie** Frequency Meters and many other items of VHF equipment. Klystrons type 723/AB 2K22, 2K39, etc., CV 129.

WANTED.
At your price TS 148 or TSX-4SE spectrum Analyser. TS 174/U or TS 175. TS 13 signal generator or TS 45 and any of the above type of equipment.

Shop hours : 9.30 a.m. to 6 p.m. Thursday to 1 p.m.

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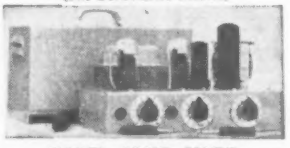
(Nr. SCRUBBS LANE) Tel.: LADbroke 1734



MODEL AC10E £10/7/6

AMPLIFIERS. College general purpose units. **MODEL AC10E** 4 valve 10 watts. Neg feedback **£10/7/6. MODEL AC15E,** 6 valve: 15½ watt P/P output. Feedback over 3 stages, **£15/5/-. MODEL AC25E,** 24 watts P/P output. Feedback over 3 stages, **£18/18/-. MODEL U10E,** for DC/AC mains, 6 valve 10 watt P/P output. Feedback over 3 stages, **£12/19/6.** All are complete with cases and chrome handles. They have a separate microphone stage. Separate inputs for mike and gram., allowing individual mixing, etc. Outputs match 3, 8 or 15 ohms speakers. Max. inputs volts required for full stated output average Mike .003, Gram. .3 v. **MODEL AC8C,** 5 valve P/P 8-10 watt unit for records, radio, etc. Feedback over 3 stages. Output to 3, 8, 15 ohms, **£10/10/-. MODEL AC4C,** 3 valve record/radio amplifier, 4 watts to .3 ohms, **£5/15/-.** Ditto U4C for DC/AC mains, **£5/15/-.** Stamp for list. Full range of accessories available including: Rothermel Crystal Mikes, **105/-** ; Goodmans 12in. P.M. speaker, **£9/12/6** ; Collaro A.C. Record Players, rim drive, magnetic model, **£6/9/-.** Crystal, **£6/15/-.** Jack plugs, **2/-** each extra.

All amplifiers are complete and ready for use.

TELEVISION

for "Fringe" and "Long distance" viewers is vastly improved with the SPENCER-WEST type AC/3 Pre-Amplifier. The specification includes a first stage neutralised triode cathode coupled to a grounded grid triode. The optimum arrangement for best "noise factor". Self-contained power supply unit complete with correctly adjusted interference filter. Price complete, **10 gns.** from your dealer or direct. Leaflets, etc. on request.

WENVOE CONVERSION

Type AC/4 WL (Wenvoe/London) and Type AC/4 WB (Wenvoe Birmingham) Convertor units for perfect simple conversion of your receiver. Price complete with 5 valves and self-contained power supply unit, **15 gns.** Descriptive leaflet on request.

SPENCER-WEST

QUAY WORKS, GT. YARMOUTH

Phone : Gt. Yarmouth 3009

PULSE INSTRUMENTATION BY SOLARTRON

PULSE GENERATOR

MODEL OPS 100

PULSE WIDTH : Continuously variable 1 — 100 microseconds.

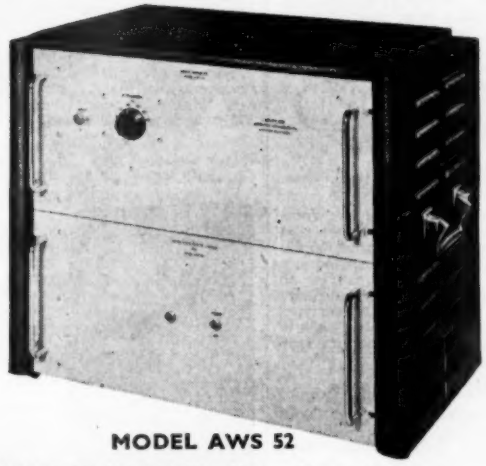
PULSE OUTPUT : 1 — 70 volts positive.

PULSE DELAY : Variable 2 — 4,000 microseconds from sync output pulse.

RISE TIME : Less than 0.1 microsecond.

TRIGGER REPETITION RATES :
1 — 50,000 p.p.s. for pulse input.
50 — 50,000 p.p.s. for sinewave.

VIDEO AMPLIFIER



MODEL AWS 52

FREQUENCY RESPONSE : 50 c/s — 20 mc/s ± 1.5 db.
NATURAL RISE TIME : 0.02 microseconds.
GAIN : 50 db adjustable on attenuator in 10 db steps.
OUTPUT : 150 volts peak to peak, push-pull.

These two instruments form an ideal combination for testing all types of pulse circuitry. Of particular note is the very wide band width of the Video Amplifier, enabling pulses of extremely short duration to be viewed on a C.R.T.

Write for details of these and other instruments to :—

SOLARTRON LABORATORY INSTRUMENTS LTD., 22 High St., Kingston, Surrey. KINGSTON 8981 P.B.X

MODERN ELECTRICS LTD.,

164, Charing Cross Road, London, W.C.2. 'phone TEMple Bar 7587.

Export enquiries welcomed. *Immediate delivery from stock.* *Prompt attention to post orders.*

TAPE RECORDERS

SOUNDMIRROR
Table Model £69 10 0
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New Model Mk. 2, £68 5 0
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New Model IA..... £83 0 0
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Portable Battery Model..... £59 0 0

RECORDING TAPE

GRUNDIG
L.G.H., 1,200ft. £2 0 0
SOUNDMIRROR
Paper Tape £1 5 0
Spare Spool 6 6
E.M.I. H.60, 1,200ft. £1 15 0
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1,200ft £1 15 0
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SIMPHONIC
As advertised £1 15 0

VALVES
We are one of London's Largest Stockists — Please write for requirements.

RECORD REPRODUCING EQUIPMENT

DECCA
2-speed Motors, complete with turntable and Rubber Mat £3 18 6
3-speed, complete... £6 8 6
B.S.R.
3-spd. (Crystal T/O Hds.) £9 19 11
3-spd. (with 2 GP20 Hds.) £11 16 6
3-spd. (with 2 Decca Hds.) £13 18 6
3-spd. Auto-Mixer ... £17 17 0
GARRARD
R.C.80, less Head £16 8 6
R.C.75A, less Head ... £14 10 3
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CONNOISSEUR
3-spd. Deck £23 13 0
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GOODMANS
Axiom 150, Mk. 2..... £14 15 10
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WHARFEDALE
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Golden 10C.S.B. £9 0 5
Super 8CS/AL £7 4 4
Super 5CS/AL £7 4 4
Bronze 10 ..... £5 0 6

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Model 8 ..... £23 10 0
Model 7 (latest) £19 10 0
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D.C. Minor £5 5 0
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Carrying Cases for Models 7, 8 and 40... £3 0 0
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E.2. (Sig./Gen.)..... £28 0 0
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Double Beam 1035 ... £93 10 0
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TAYLOR
ALL NEW TAYLOR TEST GEAR IN STOCK AND AVAILABLE ON H.P. Send S.A.E. for Catalogue and Terms.

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ACOS
G.P.20 (Std. or L.P.) £3 11 5
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XLT/O £3 19 2
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Dynamic (Ruby Stylus) £12 0 8
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SOUNDMIRROR
M/C with T/F ..... £ 7 7 0
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M/C with T/F.C.51... £5 15 6
M/C less T/F.C.51 ... £5 5 0
Heavy Table Base for above £1 1 0
Hand M/C with T/F CH.51 ..... £5 15 6
Hand M/C less T/F CH.51 ..... £5 6 0
RESLO M/C (Low Imp.) £6 0 0
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FLOOR STAND
(Mic), 3 extensions £3 12 6
LEAK AMPLIFIERS
Point 1, TL12 ..... £28 7 1
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Q.25 in Cabinet £48 10 0
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" R.D. BABY DE LUXE "
Output 4 watts Incl., Pre-Amp £21 0 0

TAPE TABLES
SOUNDMIRROR—With Complete Instructions for Associated Amplifier ... £33 0 0, carriage extra.
WEARITE (limited stock), with Complete Instructions for Associated Amplifier, £35 0 0, carriage extra.

FLUORESCENT LIGHTING KIT

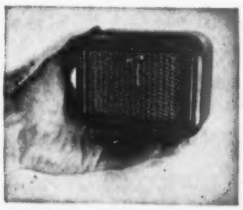
Complete kit comprises Hi-craft 40 watt control unit, starter lamp, lamp holders, clips and wiring diagram. Price 22/6 plus 1/6, or for callers only, complete with 40 watt daylight tube, 32/6.

FLUORESCENT LIGHTING BALLAST UNITS

40-watt Type. This is a combined condenser and choke unit for controlling fluorescent tubes. The only other item needed is a starter switch which can be an automatic type or an ordinary on/off manually operated type. We offer these well made units at less than half price, namely 16/6 each.

STARTER LAMP

For fluorescent lighting 2-pin SBC holder, suits all types of tubes, 3/6 each. Lamp holder 2-pin SBC, 1/9.



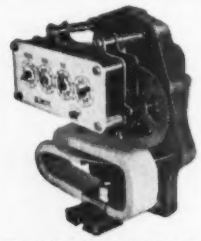
STILL AVAILABLE TAX FREE.

MIDGET EXTENSION SPEAKER

3½in. moving coil speaker in bakelite cabinet with metal grill and back fitted with terminals, size 4½in. × 4½in. × 2in. Ideal as desk extension or for bedroom, kitchen, etc. Also makes good microphone. Price 18/6, or cabinets only 6/6.

R.F.-E.H.T. FOR VCR.97

Users will know that EHT mains transformers can sometimes be unreliable and unsatisfactory, therefore we feel sure that this new addition to our range of kits will be welcome. The kit comprises 2 valves, smoothing condensers, filament transformer and all necessary parts. Price 20/-, plus 1/6 post. Constructional and operational data free with kit, or separately price 2/6.



FERRANTI ELECTRIC METER MOVEMENT

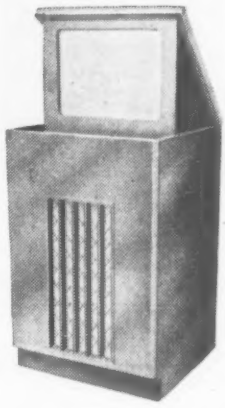
A complete check meter, except for case brand new and unused. Has many uses, one for instance is that of telling the number of hours a piece of apparatus has worked. Price is only 17/6, post, etc., 2/-.

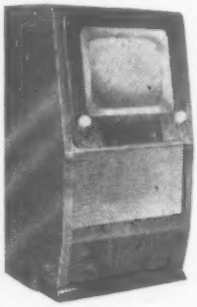
CABINETS—LESS THAN COST

Through the misfortunes of a big manufacturer we are at the moment able to sell you superior cabinets at low prices. Prices, incidentally, which are below actual cost. Obviously the quantity is limited and once sold that's the end, so you must act quickly. Call at either Ruislip or Fleet Street or send your order to-day.

An impressive cabinet designed for projection T.V. but also very suitable for a good quality radiogram or amplifier. Size 23in. wide × 22in. deep, 37½in. high with lid closed.

Price £9/15/- plus 15/- carriage. Or H.P. terms £3/5/- deposit.





A 12 inch console T.V. fitted with castors and front flap for controls. Size 19in. × 35in. × 15½in. deep.

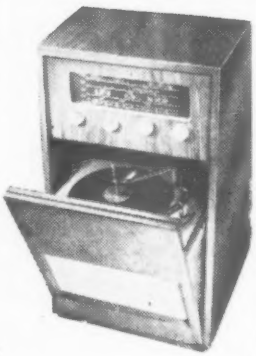
Price £7/10/- plus 10/- carriage. Or £2/10/- deposit.

A 12in. Table Model complete with armour-plate glass and surround as illustrated, £3/17/6, plus 7/6 carriage and insurance.

Mechanical details for the Console or Table Model available as a parcel. Punched and prepared metal chassis, punched outrigger, valve plate with spacers, 12in. Tube clamping ring, tube rear support, brackets, etc. Price 25/-, plus 2/6. Post included free with this parcel, circuit diagram and details of 5 Channel 12in. T.V. which uses these cabinets, chassis, etc.

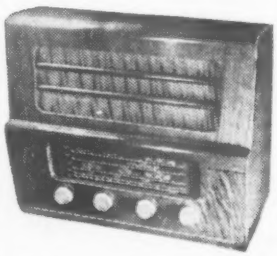
A sensible radiogram—will take the Collaro 3 speed changer RC511, etc. Size 18in. × 30in. × 11in. to 16in. deep.

Price £7/10/-, plus 10/- carriage. Or £2/10/- deposit.



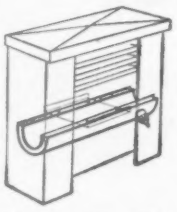
Two very nice radios which will blend with any surroundings. Size 17½in. × 15½in. × 6½in. Price 27/6.

Size 19½in. × 16½in. × 8½in. Price 32/6.



3 colour scale, scale pan, chassis, pulley, driving head, springs, etc., to suit the radiogram and two radio cabinets are available as a parcel at 15/-, plus 1/6 post.

MAKE A CONVECTION HEATER



Using Ex-Admiralty HEATING UNITS fitted with 3 pin brass plug and socket. Copper-clad enclosed elements are used and those again are enclosed in sheet metal half cylindrical containers. Fit one of these into a metal cabinet, and you have an excellent convection heater. In places where appearance is not important all you need extra is the wire as the heaters work perfectly well as they are, without extra casing, the actual elements being totally enclosed.

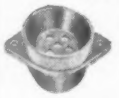
500 W. 220/230 v. 12 0

Sketches and details of suitable cabinet are supplied with each heater. 2 K.W. 110 v. heating units are also available at 7/6 each. These are ideal working in series for greenhouse heating, etc., or for space heating under benches, etc. Eight of these in series will consume 1 K.W. and will spread the heat out over a wide area. Carriage 5/- extra per heater.

RADIO HEARING AIDER

The world for a deaf person must be particularly blank and monotonous, and a hearing aid which will function as a radio when not needed for hearing should help considerably. Due to Purchase Tax no kit of parts for this will be made available but constructional data and technical notes dealing with this are available, price 2/6. Only standard parts are incorporated, therefore the constructor will have no difficulty in making this up.

HIGH VOLTAGE VALVE HOLDERS



For four or five pin valves. Price 2/9 each.

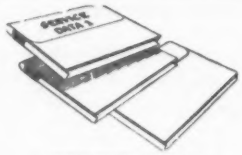
SHORT WAVE TUNING HEART

Coil Pack, 2 gang condenser, IF transformers and calibrated scale for frequency coverage of 13-37 metres, 37-100 metres and 200-500 metres. Price 39/6 complete with circuit diagram.

A POWER PACK FOR 15/-

Efficient power supply, O.K. for operating a receiver, amplifier, instrument or other device requiring up to 60 mA. at approx. 250 v. Parcel consists of filament transformer, rectifying valve, smoothing resistor and 16×16 mfd. 350 v. electrolytic condenser. Note the filament transformer will supply enough current to operate 3 or 4 other 6.3 valves.

Advertisement by Electronic Precision Equipment Ltd., see overleaf

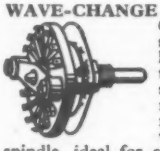


SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makers are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price **£1** for the complete folder.

Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry," etc., which have been imported into this country. Names include Sparton, Emmerson, Admiral, Crossley, R.C.A. Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is **£1.** Post free.

WAVE-CHANGE SWITCHES



Of course we stock all popular sizes and types, but special this month is a midget type with long spindle, ideal for coil pack, etc. Price **2/11.** Double pole, double throw, suitable for reversing models or plain on/off, etc. Price **1/9.**

CARBON RESISTORS

¼ watt, **4d.** each,
½ watt, **5d.** each.
1 watt, **6d.** each.

SMALL CONDENSERS

Moulded mica, silver mica, ceramic, paper tubular, all values up to .01 mfd. normal 350 v. working, **6d.** each, 5/6 doz.
.01 mfd., **6d.** each.
.1 mfd., **9d.** each.
.5 mfd., **1/-** each.
1 mfd., **1/3** each.

SHEET PAXOLIN

Invaluable for when you are experimenting. Size 6in. × 6in., **1/-.** Size 12in. × 8in., **2/-.** Size 12in. × 12in., **3/6.** Size 24in. × 12in., **6/-.**

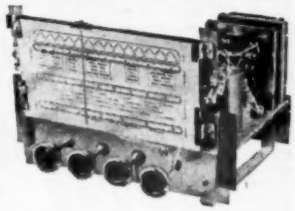
SPECIAL OFFER THIS MONTH

12 pieces each 8in. × 5in. medium thickness for **6/-.**

I.F. TRANSFORMERS

465 kc/s iron dust cores fitted in aluminium can, size 1½in. × 1½in. × 3½in. Price **12/6** pair.
Midget type, 465 kc/s, size 1¾in. × 1⅜in. × ¾in.(M400B) Price **17/6** pair.
465 kc/s.
Ex-equipment in good condition, fitted in standard size can, dust cored. Price **7/6** pair.

OUTSTANDING VALUE OF NEW PRODUCTION

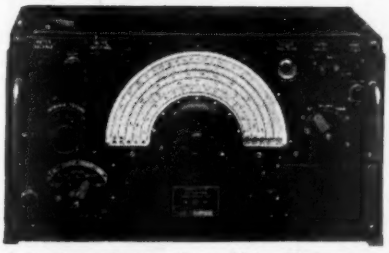


Model B. Six Wavebands, 11–15 metres continuous in 5 ranges (4 Bandspread) and M.W. 185–550 metres. Six position Tone Switch (3 Radio —3 Gram). Price **£15/15/-,** plus 7/6 carr. and insurance, or H.P. terms **£5/9/-** deposit.
Model B3. Three waveband, Long. Medium, Short, Gram switching on wave change switch. 3 position Tone. Price **£12/12/-,** plus 7/6 carr. and insurance, or H.P. terms **£4/6/-** deposit.
Both chassis 11½in. × 7in. × 8in. high. Latest type valves: 6BE6, 6BA6, 6AT6, 6BW6, 6X4. A.C. mains operated, flywheel tuning, negative feedback over entire audio section, engraved knobs, fully guaranteed.

BUILT TO HIGHEST PERFORMANCE STANDARD AND SPECIFICATION.

T.V. SERVICING AID

Will enable service engineers to check video response, stage gain, etc., without removing the chassis from the cabinet.
Kit comprises: B7G Plug, germanium crystal and indicator lamp together with making and operating instructions. Price only **6/6.**
Ditto, available for B9A, also **6/6.**



R.1155
This set, as most will know, is considered to be one of the finest communications receivers available to-day. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F., so obviously a robust receiver which will give years of service. Slightly used but completely overhauled and guaranteed in perfect working order. PRICE **£7/19/6** or will be sent against a deposit of **£2/14/-,** balance of 12 monthly payments of **11/6.** If you cannot call to collect please include an additional 10/- to cover cost of transit and carriage. This partly returnable to you if and when you return the transit case.

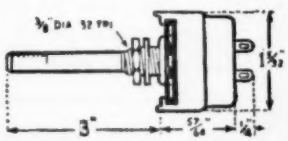
MAINS POWER PACK FOR R.1155

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price **£5/10/-** complete with 5in. speaker ready to work, carriage 3/6.

IDEAL GENERAL PURPOSE RECEIVER

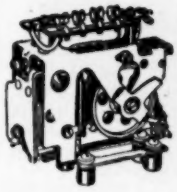
The Elpreq "Wolsey" 5 valve A.C./D.C. superhet has a built-in aerial and is of convenient size and weight to carry from room to room. Powerful reception on long, medium and short waves — handsome wooden cabinet — illuminated glass dial, with station names, A.V.C. and usual refinements. Size 11in. × 5½in. × 7in. with B.V.A. valves, 12 months' guarantee. Limited quantity only. **£9/5/-** or **£3/2/-** deposit and balance over 12 months, carriage and insurance, 5/-.

VOLUME CONTROLS



We carry a full range of standard-size volume controls from 2K, to 2 meg. Prices are: less switch, **3/-:** Single pole switch, **4/-:** double pole switch, **5/-.** We can also supply midget-type controls, less switch, **4/-:** single pole switch, **5/9:** double pole switch, **6/6.** Each of these midget controls has a serial number and carries a 12-month guarantee by the makers; they are made on the new moulded track principle and really do perform well.

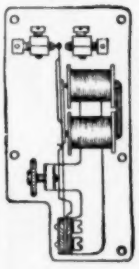
This month's special offer is an assortment of potentiometers compiled after taking a census of values required for the most popular circuits. All first-grade components. 12 potentiometers including 2 with single pole switch and 2 with double pole switch. Price 29/6.



RE-MOTE CON-TROL

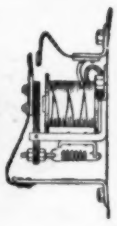
With only one pair of wires and a simple push button you can select any one of four stations without leaving your armchair. This is just one of the many applications of our impulse relay. There are many other purposes to which it can be put. Note they are somewhat soiled due to storage but mechanically O.K. Price **2/6.**

RELAYS



Extra light weight, extra sensitive for high speed or radio control work, weight only 1¼ oz., closes on 2 mA., solid platinum changeover contacts, adjustable pressure. Price **13/6.**

CONTACTOR



For breaking 25 amps, coil voltage is 24 v. D.C., but with a re-wind or a small rectifier these will close off A.C. mains. Very heavy duty solid silver contacts. Price **3/6.**

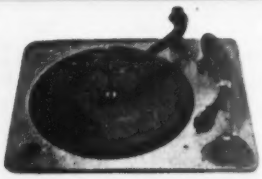
STANELCO WIRE JOINTER

This jointer melts the twisted wires and causes the metal of each to run together, thus making a strong and permanent weld. It obviously is not intended to replace the soldering iron but nevertheless is ideal for making joints that have, for instance, to withstand heat, vibration, chemical action, etc. In many cases also this method is faster than soldering and there is usually a considerable saving of current. Price **9/6.**

APPLIANCE LEAD

As fitted to H.M.V. appliances, it is 9ft. long, made of almost indestructible non-kink flex with rubber end support; ends are all prepared and bound. Price **2/9** each, **30/-** doz.
Ditto, but W. & G. with 3 core and fitted with earthed iron adaptor, **3/9.**

Advertisement by Electronic Precision Equipment Ltd., see overleaf



THREE AUTO CHANGER BARGAINS

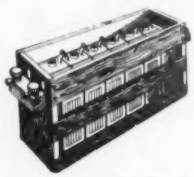
Garrard RC72 3-speed with dual-purpose head, **15 gns.**
Collaro RC511 3-speed with dual-purpose head, **11 gns.**
Garrard R70B single-speed with crystal head, **10 gns.**
Carriage and packing 7/6 extra.

UNSPILLABLE ACCUMULATORS

Very best make clear celluloid case. Size 4¼ × 2¼ × 3⅛in. 11 Amphour. Price **14/6.**

TWO-VOLT ACCUMULATORS

Made for the Forces by one of the most famous firms in the world. 15 amp.-hour size approx. 6in. × 1¾in. square in ebonite case, pre-charged, only need filling with acid, **4/9** each, plus 9d. post and insurance.



12 CELL ACCUMULATOR

This accumulator can be coupled up to give 24 v. with all cells connected in series or 12, 6 or 2 volts in series parallel arrangements. They were originally made for the Admiralty by a leading manufacturer, have never been filled, and are in excellent condition. Each is contained in a wooden crate as illustrated. Post and insurance 2/6. Price **27/6.**

PUSH BUTTON SWUTCHES

Nine push type, **3/6.** Four push type, one operates mains on/off switch, 2/9. Three push type, **2/3.** Knobs **1d.** each extra.

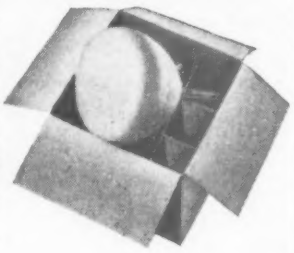
BE PREPARED

For a cold winter by making our low cost Electric Blanket. 27 yards of special heater wire and blueprint 20/-. Blueprint only **1/6.** Alternatively make a Bed Warmer. Constructional data **1/6.**

STAND OFF INSULATOR

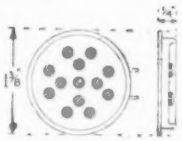
Vitreous porcelain. Price **1/-** each or **10/-** doz.

STILL AVAILABLE
15in. MAGNETIC TELEVISION TUBE.



By famous maker, as used in many popular Television receivers (list on request). Specification Blue/White screen 9 Kv. ion trap triode, heater 6.3 v. at .55 amp., 50 deg. deflection. New, with written guarantee offered at approximately half price, **£12/10/-** each, plus 10/- carriage and insurance. H.P. terms **£4/4/-** deposit and 12 monthly payments of **18/3.** Limited quantity so order immediately.

CRYSTAL MICROPHONE



Diaphragm driven, extremely sensitive, made for deaf aid but highly suitable for recorder work. 10/6 each.

RADIO GRAM CABINET

Console Type Cabinet. With full grained walnut finish, will take standard type auto change gram unit. Price, **£11/10/-.** H.P. Terms, **£3/17/-** deposit, and 12 monthly payments of **16/9,** plus 15/- carriage.

Radio Chassis to suit. **£8/19/6.** H.P. Terms, **£3** deposit and 10 monthly payments of **13/-,** plus 7/6 carr.

Auto Change Units. For long playing and standard records with suitable pick-up head. **£11/11/-.**

SPECIAL OFFER. Cabinet, Radio Chassis and Auto Changer, **29 gns.** H.P. Terms, **£10/14/-** deposit and 12 monthly payments of **£2/3/-.**

PICTURE TUBE REJUVENATOR

With tubes which are failing through loss of cathode emission due to softness, etc., 6 or more months' extra use can usually be obtained by a novel method, see article in December issue of "Practical Television." Method involves use of a mains transformer with multi tapped secondary variable wire wound resistors and several small components, all available as a kit of parts at **35/-** complete. Constructional data and technical notes are free with the kit or available separately price **2/6.**

LAST FEW—£3/19/6

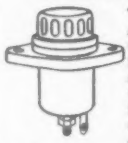
The "Lectross" is a convector room heater which can be a clothes drier on washing days. It will make life easier in any home, but is an extra boon in flats and where washing is done in the evening.
We have sold a lot of these, and purchasers have been delighted. In fact many find it difficult to believe we can supply at such a low price. We could not, but for the fact that the "Lectross" manufacturers were forced into bankruptcy by a cancelled export order. We are able to offer these to you at less than half the original price, and only a quarter of what the price would be if they were made to-day. We also bought all the spare parts, so you need have no fears about repairs; in fact, we guarantee always to be able to supply spares.
The "Lectross" Clothes Drier/Room Heater is 3ft. wide, 3ft. high × 5in. deep. It has four stove enamelled rails and works off A.C. or D.C. mains, consuming 650 watts. Price **£3/19/6,** plus 7/6 carriage.

MAINS TRANSFORMER SNIP

Heavy duty mains transformer, with 5 secondaries, suitable for big Amplifier, T.V., etc. **Primary:** 200, 220, 240 v. **Secondary 1:** 360-0-360 v. at 200-250 mA. **S2:** 6.3 v. at 5 amp. **S3:** 4 v. at 3 amp. **S4:** 4 v. at 3 amp. **S5:** 5 v. at 3 amp. Half shrouded drop through chassis mounting. Price 29/6, plus 1/6 postage.

SUNDRIES

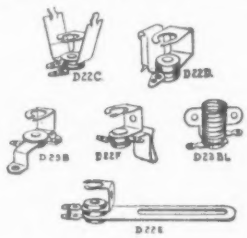
INDICATOR LAMP



This is fitted with a clear Perspex top, it is therefore highly suitable as an indicator lamp or for illuminating inside a radiogram or similar cabinet or even as a map-reading light in a car. Takes standard screw-in flash light bulb. Price 1/6 complete.

LAMP HOLDERS

We carry a large assortment of dial lamp holders. Price **6d.** each. Order by list numbers.



2-PIN PLUG (C20B)

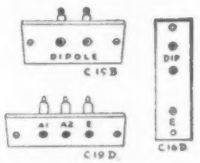
Split Pin type, fits most of our sockets, C16A, C16B, etc., **6d.** each.

SPECIAL SWITCHED PANEL (C16A)

This is a 2-socket panel with optional switching for internal and external L.S. Just inserting two pin plug, C20B gives both speakers, pushing it right home cuts out internal speaker. Price **9d.** each.

SOCKET STRIPS

Paxolin mounted.



Two socket engraved L.S. **6d.** each. Bin. C16B.

Two socket engraved A.E. **6d.** each. Bin. C18A.

Two socket engraved P.U. **6d.** each. Bin. C19B.

Two socket engraved Dipole **6d.** each. Bin. C19B.

Two socket plain. **5d.** each. Bin. C18B.

Three socket engraved DIP and E. **9d.** each. Bin. C16D.

Three socket engraved A1, A2 and E. **9d.** each. Bin. C19D.

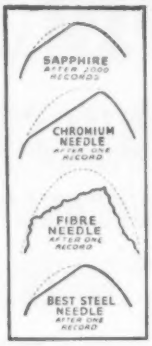
Four socket engraved A.E. Pick-up. **9d.** each. Bin. C19E.

Four socket engraved P.U. Ext. L.S. **9d.** each. Bin. C16E.

Five socket plain. **9d.** each. Bin. C16C.

Advertisement of Electronic Precision Equipment Ltd.

THE PERFECT NEEDLE SCIENTIFIC PROOF



Shadowgraph tracings of various needles tested show their points enlarged hundreds of times. Notice that the finest steel needle is worn more by one record than the sapphire is by 2,000 playings.

1. No record wear.
2. Brilliant tone quality (full range) and low surface noise.
3. Freedom from needle changing.

Precision made stylus .0625in., radius .0025", angle 60°, straight ½in. long, also trailer type, 3/9 each (either type).

EX-GOVT. CATHODE RAY TUBES

VCR97. Brand new and unused, these are not the "cut-off" type. Gives full picture. Price 42/6. Carriage and insurance 5/- extra.

4/1 3in. Electrostatic, 37/6, plus 2/6 carriage, etc.

VCR139A. 2½in., 37/6, plus 2/6 carriage, etc.

VCR138. 3½in. electrostatic short persistence, suitable for T.V. and ideal for 'scope work, 37/6, plus 3/6 carriage, etc.

VCR112. 5in. electrostatic, persistence not known, 22/6 each, plus 5/- carriage, etc.

CV996. 6in. electrostatic, persistence not known, 22/6 each, plus 5/- carriage, etc.

CV1140, CV1590, CV1546. All 12in. magnetic long persistence, £4/10/-, plus 10/- carriage.

WHITEWOOD CABINETS

Hundreds of uses in the home, office or workshop; for instance two of these and 3/- worth of hardboard (obtained locally) make an excellent desk or workbench. Sturdily constructed of well seasoned softwood frames and fronts, birch ply top, sides and doors, hardboard backs and bottoms. External dimensions 29in. × 14½in. × 13½in.

Model 314

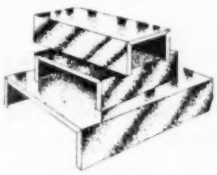
Model 313C. Drawer, space and cupboard, half shelf inside cupboard. Price 39/6.

Model 314. Five Drawer Chest, suitable for personal papers, etc. Price 45/-.

Model 313C

Model 313A. Well built cabinet with shelf and cupboard. Fitted half shelf inside cupboard. Price 37/6.

Model 314 & 313 as desk

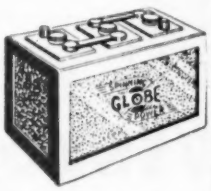


BLANK CHASSIS
18 S.W.G. Aluminium

7 × 3½ × 2 ..	5/-	16 × 10 × 3 ..	8/3
9½ × 4½ × 2½	5/9	16 × 8 × 3 ..	8/-
10 × 8 × 2½ ..	7/-	11¾ × 10 × 3	7/6
10 × 5¼ × 2½	6/6	16 × 12 × 3 ..	8/8
10 × 9 × 3 ..	7/3	19¾ × 9 × 2½	8/3
12 × 9 × 2½ ..	7/3	20 × 10 × 3 ..	10/-
14 × 9 × 2½ ..	7/6	21¼ × 9⅛ × 2½	10/6
14 × 10 × 3 ..	8/-		

6-VOLT AMERICAN HEAVY-DUTY BATTERIES

Made by one or other of the most famous American battery companies. For reliability and long service between charges these are in a class of their own. Capacity rating is 140 amp-hour. We have a limited quantity of these batteries available, unused—in fact they have never been filled with acid, and the price is £5/10/-, carriage extra at cost depending upon your locality.



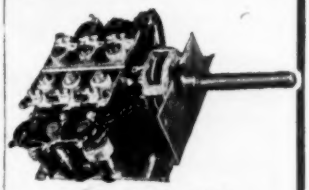
EXTENSION SPEAKER IN METAL CABINET

This has a 6½in. P.M. Goodmans Speaker, heavy magnet type, complete with an output transformer. It is fitted in grey steel case with perforated front and back, ideal for P.A. work in canteens, clubs, etc., 27/6 each.

MILLIBAR BARO-METER, 7/6

The heart of a barometer is a metal bellows which will expand and contract with the varying air pressure. The aircraft altimeter works on the same principle, a series of gears and lever amplifying the expansion and contraction of the bellows and so works the pointer.

We can offer the ex-R.A.F. Sensitive Altimeter slightly faulty but containing the essential bellows, gears, wheels, etc., from which a good barometer can be made. Price only 7/6, plus 1/- post.



COIL PACK SNIP

Manufactured by quite a famous company, this 3 wave Coil Pack incorporates a gram position and Long, Medium and Short wave band, designed for 465 kc/s IF. Brand new and fully guaranteed, complete with circuit only 19/6, limited quantity so act quickly.

AERIAL STRAINERS

Brass body, price 1/6 each.

ELECTRONIC PRECISION EQUIPMENT LTD.

We have moved in at last so you can now address your orders to :—

ELPREQ HOUSE (Ref. 2), HIGH STREET, WEALDSTONE, MIDDX.

Peronal shoppers however should continue to call at :—

42-46, WINDMILL HILL, RUISLIP, MIDDX.
Phone: RUISLIP 5780
(Half-day, Wednesday).

152-153 FLEET STREET, E.C.4.
Phone: CENTRAL 2833
(Half-day, Saturday).

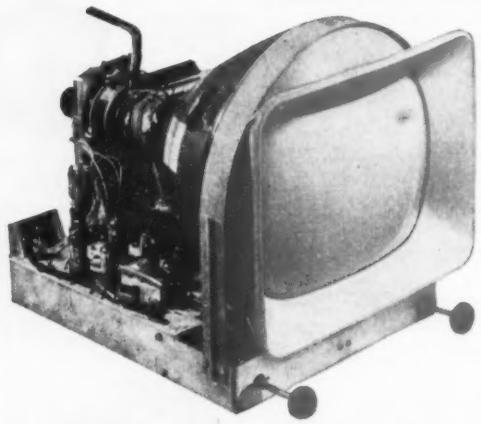
LASKY'S RADIO
"World Renowned for Service & Reliability"

TELEVISION!

OUR PRE-CORONATION OFFER

14 VALVE T/V CHASSIS. 5-CHANNEL SUPERHET.

FULLY ASSEMBLED AND WIRED. A.C. MAINS.



★Daylight Viewing. ★Black and White Picture. ★P.M. Focus, using latest 12in. ion trap picture tube. ★Line flyback E.H.T. (EY51). ★Blocking oscillator frame time base. ★Top quality components by the finest manufacturers throughout.

LATEST TYPE MINIATURE VALVES BY MULLARD OR MAZDA

VALVE LINE UP

MULLARD	or	MAZDA
7 EF80; 2 ECL80; 1 each: PL38; PZ30; EY51; EBC41; EB91; Xtal diode.		7 10F1; 1 20F2; 2 20L1; 1 20P1; 1 each: EY51; U281; 10LD11: 20D2; Xtal diode.

SIZE: 12½" wide, 14" deep, 14" high.

COME ALONG AND SEE THIS SET WORKING

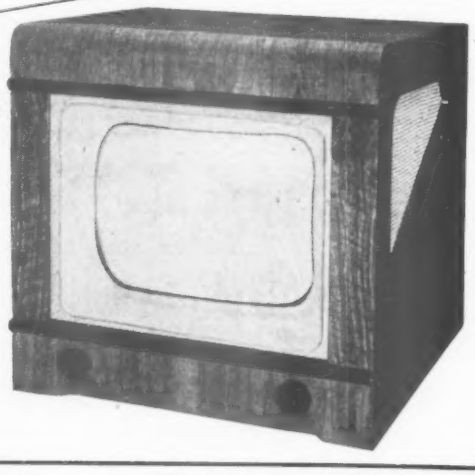
LASKY'S PRICES

Chassis.	Less valves	£12 12 0	Soiled
"	" "	£14 19 6	Perfect
"	Complete	£19 19 0	Soiled
"	"	£23 7 6	Perfect

All chassis supplied less C.R. Tube.
Carriage and packing and insurance 17/6

CATHODE RAY TUBES
Mullard MW31-16..... £18 4 10
Ion trap...5/-

CARRIAGE FREE IF PURCHASED WITH CHASSIS



TELEVISION TABLE CABINETS.

12 INCH.

High polish, walnut veneer. Size: 16in. wide, 17in. deep, 15in. high. Supplied complete with 12in. mask, armour plate glass, 6½in. closed field loud speaker, back with C.R.T. rear protector, 2 knobs and speaker baffle.

LASKY'S PRICE 79/6

Carriage and packing 10/- extra.

LASKY'S

Lasky's (Harr
370 HARROW ROAD, PA
(Opposite Paddington Hospital) Tele
MAIL ORDER & DESPATCH DEPARTMENTS, 485/487

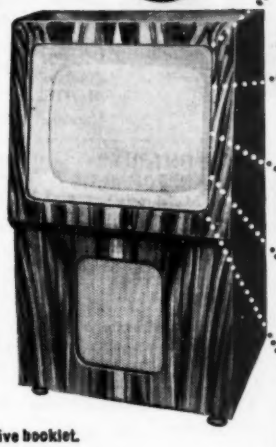
Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m.

Introducing the

TELE-KING

laboratory developed

16"



A practical 5-channel

SUPERHET TELEVISION RECEIVER

Using the new 16-inch cathode ray tubes and wide angle components for the home constructor.

Complete instructions, wiring diagrams and 32-page descriptive booklet.

6/- POST FREE

ALL COMPONENTS IN STOCK. WRITE FOR LIST.

LASKY'S RADIO — World Renowned for Selection & Reliability

CHASSIS
Power pack; Sound-vision and Scan chassis. PRICE 15/- each. All other metalwork available from stock.

COILS
13 All exactly as specified. PRICE £2/14/3.

RESISTANCES
72 Resistances, all exactly as specified, 18/-.

CABINET
As illustrated £8/10/0 plus carriage.

ALLEN WIDE ANGLE COMPONENTS

DC.300 Coils	£2 2 0
GL.16 Coil	10 0
GL.18 Coil	10 0
Focus Coil	£1 15 0
FO.305 trans.	£1 1 0
Frame B.O.T./fr.	15 0
Line EHT. transformer, 10-16 Kv. L.308	£2 10 0

C.R.T. MASKS. Brand new

LATEST ASPECT RATIO
10in., 7/6; 12in., 15/-; 12in. flat face, 15/-; 14in. rectangular, 21/-; 16in. Double-D, 30/-; 17in. rectangular, 27/6.

SOILED OLD ASPECT RATIO
9in., 5/-; 12in., 7/6; 15in., 10/-; 12in. with fitted armour plate glass (new ratio), 11/6.

ARMOUR PLATE GLASS
15in. Actual size 18¼in. × 19¼in. × ⅛in. 7/11
12in. Actual size 13in. × 10¼in. × ¼in. 4/-
9in. Actual size 9in. × 8in. × ¼in. 3/-

DARK SCREEN FILTERS (LATEST TINT)
12¼in. × 14¼in. For 16 and 17in. c.r. tubes, 25/-.
11in. × 13¼in. For 9, 10 and 12in. c.r. tubes, 15/11.

USED CATHODE RAY TUBES
For Callers Only. These tubes have either heater—cathode shorts and/or ion burns. Ideal for experimental and testing purposes.
9in. 35/-
10in. 45/-
12in. 55/-

Line EHT Transformer, with EY51 heater winding, 12/6.

Focus Magnet. With Vernier Control. For any type c.r. tube with 35 mm. diam. neck, 21/6. Less Vernier, 15/-.

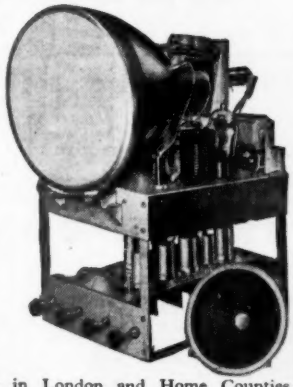
Multi-Ratio Frame Output Transformer, 10/6.

Scanning Coils. High impedance frame, low line, 12/6. Plessey. Low impedance line and frame, 25/-.

WIDE ANGLE CATHODE RAY TUBES
14in. rectangular £21 5 8
17in. rectangular £26 19 8
16in. round metal cone ion trap tube £24 6 5
Carriage and insurance extra.

Variable Inductance Width Control, 3/6.
Plessey, 6/6.
C.R.T. Rear Neck Protectors, 2/6.

THE VIEWMASTER



The television set you can build at home from standard parts.
Wenvoe, Kirk o'Shotts, Holme Moss, Sutton Coldfield and Alexandra Palace operation. Brilliant high definition black and white picture.
Superb reproduction.
Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model.
Incorporates all the latest developments.
Television for the home constructor at its finest.
Send to-day for the CONSTRUCTION ENVELOPE, 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions. Model "A" for use in London and Home Counties. Model "B" for use in Sutton Coldfield Area. Model "C" for Holme Moss. Model "D" for Kirk o'Shotts. Model "E" for Wenvoe.

PRICE Post free **7/6** per copy.

ALL COMPONENTS IN STOCK AND SOLD SEPARATELY.

COILS
All models available including filter chokes. Wenvoe, Kirk o'Shotts, Holme Moss, Sutton Coldfield, 28/- per set. Alexandra Palace, 20/- per set. L9 RF choke, 2/-.

CHASSIS
Sound-Vision, 18/6. Power-Pack/Time base, 18/6.
Support for S.V. chassis, 6/-.

W/B & PLESSEY

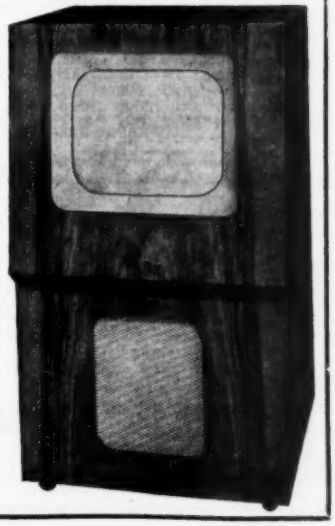
Line EHT trans.	32/6
Frame trans.	25/6
3 Mc/s boost choke	5/9
Width control	10/-
Scanning coil	33/3
Main choke	15/6
Focus ring	22/6
Heater trans.: WB/103	42/-
WB/103A	52/6
Front and rear C.R.T. supports	21/6

METAL RECTIFIERS.
WX3 and 6. Each 3/9

14D36	11/8
14A86	20/4
36EHT45	23/8
36EHT50	26/1
36EHT100	29/6

LATEST 12in. PLASTIC MASK
Incorporates gold finish tube escutcheon and dark screen filter. Overall dimensions: 13¼in. wide, 10¼in. high.
17/6d. Post 2/6 extra.

DE LUXE TELEVISION CABINETS



For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster. "Practical Television," "Practical Wireless," and "Wireless World" televisors.

LASKY'S PRICE £8.10.0

Carriage 12/6 extra.

Outside dimensions of cabinet 17¼in. × 16¼in. × 32in. **Why not convert your table receiver to a console?** Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

This cabinet can also be supplied cut out for a 16in. C.R. tube.

RADIO

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DDINGTON, LONDON, W.9

phones: CUNningham 1979 and 7214

Harrow Rd., Paddington, London, W.10. Tel. LADbroke 4075

TERMS: PRO Forma, Cash with order, or C.O.D. on post items only. Postage and packing on orders value £1—1/-, extra £5—2/- extra, £10—3/6 extra. Over £10 carriage free unless specifically stated otherwise.

LASKY'S RADIO

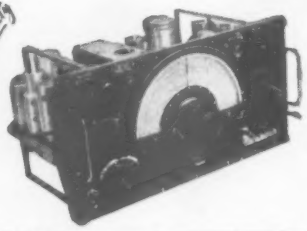
World Renowned for Service & Reliability

R.1155 RECEIVERS. BRAND NEW.

AERIAL TESTED BEFORE DESPATCH

These well known Ex. Air Ministry Receivers need no further introduction.

Supplied complete with 10 valves.



LASKY'S PRICE **£11 . 19 . 6**

USED MODELS **£7 . 19 . 6**

Carriage 12/6 per unit extra.

Fully Assembled Power Pack and Output Stage, for R.1155 Receiver. For use on 200-250 volts AC mains. **LASKY'S PRICE 79/6** Carriage 5/- extra.

TEST PRODS. Fused, with fully retractable points. Price 4/11 per pair.

SUPERHET COIL PACKS. 3 Wavebands: 12-35 metres; 35-100 metres; 200-550 metres. Size: 4×4×3in. Price 16/-.

METAL RECTIFIERS

6 v. 1 a.	6/9
6 v. 4 a.	17/6
12 v. ½ a.	3/11
12 v. 4 a.	17/6

RF.25 UNITS. BRAND NEW AND UNUSED. For use with 1355 Receiver. Supplied with 3 new SP61 valves. 19/11. Carriage 2/6 extra.

I.F. TRANSFORMERS

Midget. 465 Kc/s. Iron dust cores in can, size:—1in. × 1in. × 2½in. high. 12/6 per pair.

WEARITE TYPE 500. Range 450-470 Kc/s. Dust cored compression trimmer tuned. In can, size:—3½in. high, 1½in. square. 12/6 per pair.

WEARITE TYPE 550. Range 445-520 Kc/s. Permeability tuned. In can, size as for 500 series. 12/6 per pair.

SPECIAL PARCEL OF MAINS DROPPING RESISTANCES. Wire wound. .1, .2, .3 amp. 12 assorted. 15/-, post free.

BRAND NEW AND UNUSED R1132A RECEIVER. Supplied in makers' original wood transit case. Frequency coverage 100-124 mc/s. 11 Valves: 1 VR65; 1 VR66; 4 VR53; 2 VR54; 1 6J5; 1 VS70; 1 VR57. Large tuning scale with slow motion drive. 0-5 m/a. tuning meter, RF and LF gain controls, jack sockets for line and 'phone.

Totally enclosed in metal case, grey enamelled with plated handles. Size: 18 × 10 × 11in. Supplied with all valves, also circuit and calibration chart.

LASKY'S PRICE £3.19.6 Carriage 10/- extra.

P.M. LOUDSPEAKERS

All less o'trans. new and unused. First quality.

3in.	12/11
5in.	12/6
6½in.	13/6
8in.	15/-
10in.	25/-
12in.	75/-

OUTPUT TRANSFORMERS

40 mA. Multi ratio..	6/11
80 mA. Multi ratio..	14/11
80 mA. Pentode....	12/6
60 mA. Plessey, 6,000 ohms	5/11
Standard pentode ..	4/11
Pentode	3/6
Midget pentode....	4/3
Miniature pentode. 3S4, 1S4	4/6
PX4 Intervalve	8/6
5 : 1 Intervalve	5/11

ROTHERMEL (DEAF AID) CRYSTAL MICROPHONES. Diaphragm driven Extremely sensitive, can be used for tape recording, etc. Miniature, size:— 1⅝in. diameter, ⅛in. thick. 7/6, post free.

TWO-GANG TUNING CONDENSERS .0005MFD.

No. 1. Miniature. With Perspex dust cover and trimmers. Size: 1½×2×1⅝in. ¼in. spindle **LASKY'S PRICE 8/6**

No. 2. Midget. With trimmers. Size: 2½×1⅞×1⅝in., ¼in. spindle. **LASKY'S PRICE 8/6**

No. 3. Midget. Less trimmers. Size: 2 × 1⅞ × 1⅝in. ¼in. spindle. **LASKY'S PRICE 6/6**

No. 4. Standard type. Size: 2½×2⅞×1⅝in., ¼in. spindle. **LASKY'S PRICE 6/6**

THREE-GANG TUNING CONDENSER. .0005 mfd. Size 3½×2⅞×1⅝in., ¼in. spindle. **LASKY'S PRICE 7/6**

SOUND AND VISION RECEIVERS

CONSTRUCTED ON MIDGET CHASSIS

We now have in stock 3 types, including T.R.F. and 5 channel superhet models. Prices range from £6/19/6 complete. For full description write for our latest list.

R1481 RECEIVER. Soiled condition. Supplied in original wood transit case.

Frequency coverage 66-86 Mc/s. 11 Valves: 1 VR65; 1 VR66; 4 VR53; 2 VR54; 1 6J5; 1 VS70; 1 VR57. Large tuning scale with slow motion drive. 0-5 m/a tuning meter, RF and LF gain controls, jack sockets for line and 'phone.

Totally enclosed in metal case, grey enamelled with plated handles. Size: 18 × 10 × 11in. Supplied with all valves, also circuit and calibration chart.

LASKY'S PRICE 59/6 Carriage 10/- extra.

EXTENSION SPEAKERS. 3in. P.M. Complete with cabinet. Medium walnut veneer. Modern and pleasing design. Ideal for radio extension and intercom. slave units. Fitted with back. **PRICE 21/-.** Postage 2/- extra.

P.A. SPEAKERS. Re-entrant horn, 10 watts, beam projector, weatherproof speakers. 7.5 ohm impedance. Horn diameter—14in. **LASKY'S PRICE 99/6** Spigot mounting 10/- extra. Carriage and packing 15/- each.

TANNOY PRESSURE UNITS 10 watts. 7.5 ohms impedance. **LASKY'S PRICE 79/6** Carriage 4/6 extra.

CRYSTAL DIODES

G.E.C. type, Glass wire ends, 3/3 each. B.T.H. Type, Plastic, 3/- each.

AMPLIFIERS. Fully assembled and wired.

25 Watt Model. By Romac, with radio tuner, long and medium wave. 7 valves, including 2 6L6 in push-pull. Provision for high and low impedance microphone. Absolutely perfect, new and unused. For 200-250 volts 50 c.p.s. mains. £25.

Model J/RA/2. 10-12 watt, 4 valves, including 2 KT61 in push-pull. Brand new and unused. For 200-250 volts 50 c.p.s. mains. Details available on request. £7/19/6.

T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS

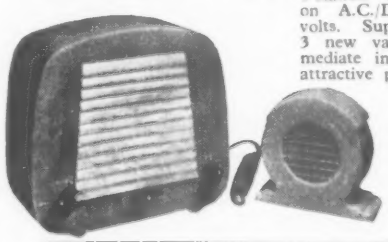
(Cathodray).

.001 mfd. 12.5 kV.	7/6
.001 mfd. 15 kV.	10/-
.001 mfd. 25 kV.	18/-
.0005 mfd. 25 kV.....	18/-
.0005 mfd. 12.5 kV.	10/-
.1 mfd. 7 kV.....	15/-
0.04 mfd. 12.5 kV.	7/6

Plastic case, single bolt fixing.

INTER-COM. SETS

4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in attractive plastic cabinet.



MASTER UNIT £7/15/-. Carr. 5/- extra.

Extension Units. As Illustrated. **£1/1/-.** Carriage 2/- each extra.

ELECTROLYTIC CONDENSERS

8 mfd. 450 v.w.	2/3
8 mfd. 500 v.w.	2/11
16 mfd. 350 v.w.	2/6
16 mfd. 500 v.w.	3/6
32 mfd. 275 v.w.	2/6
50 mfd. 350 v.w.	3/11
60 mfd. 350 v.w.	3/11
250 mfd. 12 v.w.	2/-
250 mfd. 350 v.w.	4/11
8+8 mfd. 450 v.w.	4/6
8+16 mfd. 500 v.w.	4/11
12×12 mfd. 350 v.w.	3/6
16+16 mfd. 500 v.w.	4/6
16+14 mfd. 450 v.w.	5/11
32+32 mfd. 150 v.w.	2/6
32+100 mfd. 450 v.w.....	7/6
60+100 mfd. 350 v.w.....	9/6
BIAS	
25 mfd. 25 v.w.....	1/6
50 mfd. 12 v.w.....	1/6
50 mfd. 50 v.w.....	1/6
75 mfd. 12 v.w.....	1/-

ALL BRAND NEW AND GUARANTEED (NOT EX-GOVT.)

MINIATURE BIAS. 10 mfd. 25 v.w., **10½d.** each, **9/-** doz.

MICA, AND TUBULAR CARDBOARD. All 500 v.w. From 100 pf. to .1 mfd., **6d.** each, **5/-** doz.

CERAMIC AND SILVER MICA. Most values. From 4½d. each, 4/- doz.

MINIATURE CARDBOARD. 350 v.w. All values up to .1 mfd. 7½d. each, 6/- doz.

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(Opposite Paddington Hospital) *Tele*

MAIL ORDER & DESPATCH DEPARTMENTS, 485/487

Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m.

A PORTABLE TAPE RECORDER

NOT A KIT

BUT A FACTORY BUILT JOB. By a well-known manufacturer. Simple to operate. Finest quality components throughout.

LASKY'S RADIO
World Renowned for Service & Reliability

BRAND NEW—UNUSED—COMPLETE

- ★ Attractive carrying case.
- ★ Twin track recording.
- ★ Instant playback.
- ★ Size of case: 17 × 12 × 7in.
- ★ Total playing time of 66 mins.
- ★ 6 Valves.
- ★ Weight 31 lbs.
- ★ A.C. mains 200-250 v.
- ★ Fast rewind.
- ★ Record level indicator.
- ★ Complete. Ready to switch on.

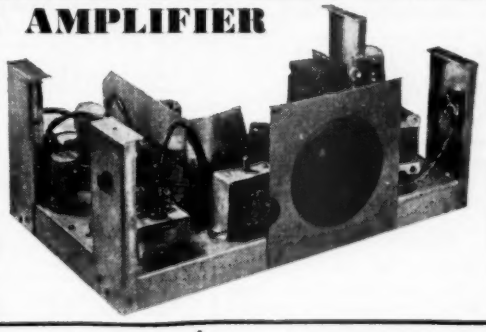
MAKE NO MISTAKE— YOU MUST SEE AND HEAR THIS

LASKY'S PRICE
£34.19.6
Carriage and insurance 15/-

Supplied fully assembled and wired, with all valves, 1200ft. spool of tape, take-up spool, crystal hand microphone, instruction book, and circuit diagram.

THE RECORDING AMPLIFIER

As used in the recorder above. 6 valves, 2 6V6, 2 6J7, 1 6J5, 1 5Z4. Supplied fully assembled and wired, with all valves and 5in. speaker. Ready for use, 200-250 volt A.C. mains. Size:—15½in. wide, 8½in. deep, 6in. high. Circuit available.



LASKY'S PRICE
£8.19.6
Carriage and insurance 10/- extra

PORTABLE CABINETS

As illustrated. Can be supplied separately.

LASKY'S PRICE **£3.15** Carriage 10/- extra.

TAPE RECOMMENDED
Scotch Boy
1,200ft. Reels 35/-
600ft Reels 21/-

MICROPHONES. CRYSTAL
Rothermel 59/6.
Acos No. 1 £6/6/-.
Acos No. 2
Complete with stand £6/6/-.
Lustraphone. Moving Coil. Stand type. £5/12/6.
Lustraphone. Moving Coil. Hand type. £5/5/-.

MICROPHONE STANDS

Table model. 2 section Chrome plated. Crackle finish base. **19/6.**

Floor model. 2 section. Brass, heavily chrome plated. **89/6.** Carriage 2/6 extra.

4-WATT AMPLIFIERS

Ex-Government. Complete with 10 valves: 2 25L6, 1 6H6, 1 25Z6, 6 6SK7. For operation on 110 volts AC/DC. Balance and push-pull. High, medium and low impedance inputs. A.G.C., etc.

LASKY'S PRICE **£7.19.6** Complete
Carriage 7/6 extra.

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ow Road) Ltd.,
DDINGTON, LONDON, W.9
phones: CUNningham 1979 and 7214.
Harrow Rd., Paddington, London, W.10. Tel. LADbroke 4075

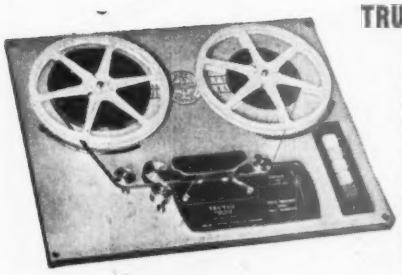
Terms: Pro Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

10,000 VALVES IN STOCK

B.V.A., Special Purpose. Transmitting, etc.
Write for our latest list.

A few Specials:
Raytheon Sub-Miniature, CK510AY, Pentodes, 3/11.
954, 956, VU120, 32, 57, E1148. All at 2/6 each.
RK34, 2/-: MS/PEN, 3/6: VU111, 3/6.
Sylvania (red), EF50, 12/6.

GARLAND



TRUVOX TAPE DESK MARK III

Incorporating high impedance mu-metal twin-track heads. Two-speed capstan, for tape speeds of 7½ and 3¾ inches per second. Three heavy-duty motors allowing for fast forward and rewind facilities without tape handling. All controls operated by electrically and mechanically interlocked push buttons. Price **£23.2.0**

Send S.A.E. for full particulars. Plus 10/- carriage, etc.

GARLAND RECORD-PLAYBACK AMPLIFIER R P 8

This amplifier is specially designed for the Truvox Tape Desk. It is built in two cable connected units (pre-amp-control unit and main amplifier), and provision is made to enable the equipment to be used as a gramophone amplifier. Built-in power supplies, bias and erase oscillator, magic-eye record level indicator, 6-watt push-pull output, 8in. P.M. loudspeaker with provision for feeding into external 3 or 15 ohm speaker. Formica control panel to match Tape Desk. Standard valves used throughout. Price **£19.19.0** plus 10/- carriage, etc. Send S.A.E. for full details.

TAPE RECORDER OSCILLATOR COILS. Inductance 6.3 mH, giving frequency of 45 Kc/s with a .002 mfd. condenser. For use with high impedance heads. Made for us by a leading manufacturer. Price 6/9 each. *Trade supplied.*

SCOTCH BOY MEDIUM COERCIVITY TAPE

We recommend this tape for use with ALL GARLAND Tape Recorders. Now available in the following lengths. 1,200ft. 35/- ; 600ft. 21/- ; 300ft. 12/3. Spare 7in. spools (1,200ft.) 4/3.

Garland Oscillator Unit

For magnetic recording. Incorporating 6V6G valve and Garland Oscillator coil and supplying H.F. bias and erase for high impedance heads. Price **£2/2/-**, plus 2/6 post. Trade supplied.

CLEAREX TELEVISION MAGNIFYING LENS

9in. clear, 55/- ; 9in. filter, 60/- ; 12in. clear, 75/- ; 12in. filter, 80/- ; Carriage and packing 5/- each on all types. (C).

RECORD PLAYERS (C)

COLLARO RC511 single-speed Autochanger. Magnetic, price £11/14/11 incl. P.T. Crystal price **£12/3/2**, incl. P.T.

COLLARO 3/RC511 3-speed Autochanger with two heads, **£18/14/1.**

B.S.R. MONARCH 3-speed Autochanger with reversible pick-up, price **£17/17/-.**

GARRARD RC.75 3-speed Autochanger, **£16/6/6.**

COLLARO AC47 single-speed turntable and motor. Centre driven by heavy induction motor. Price **£6/13/4**, incl. P.T.

COLLARO AC514 Record Player. Single speed rim-drive with pick-up. Price **£6/19/-** inc. P.T.

B.S.R. single-speed motor and turntable MU.15. Price **£3.** Fitted in portable bakelite cabinet, **£4/10/-.**

DECCA 3-speed Gram. motors. Price, incl. P.T., **£6/8/6.**

DECCA Turnover Pick-up for use with above motors. Price, incl. P.T., **£3/19/4.**

ACOS G.P.20 Standard or long playing, price **£3/11/5.** Spare heads, **£2/3/4.**

B.S.R. GRAMOPHONE UNITS. 3-speed motor with pick-up, mounted on plastic playing table. Price, **£9/19/11**, including purchase tax.

LANE TAPE TABLE (C)

Three motors ; very fast wind-on and re-wind ; automatic braking ; high impedance, half track heads ; tape speed 7½in. per sec. Price **£16/10/-**, plus 10/- carriage.

GARLAND UE7B RECORD PLAYBACK AMPLIFIER

A revised version of our popular amplifier designed to suit Truvox Tape Desk or Lane Tape Table. New features include higher gain, magic eye record level indicator, and smaller size for incorporation in portables. Oscillator and power supplies included. Standard valves throughout. Formica control panel. Supplied complete with 8in. P.M. loudspeaker. Price **£13/2/6**, plus 7/6 carriage, etc. Trade supplied.

GARLAND TAPE RECORDER LU7B (C)

Incorporating the latest type Lane Tape Table and the Garland UE7B Amplifier in portable cabinet with 8in. speaker. Complete with 1,200ft. reel of tape, spare spool, and filter cell microphone. Price **41 gns.**

GARLAND ACIV AMPLIFIER (C)

Providing exceptionally wide frequency response and low harmonic distortion at a maximum output of 11.5 watts. High and low gain inputs with bass, treble and volume controls. Standard valves throughout, **15 gns.**, plus 15/- carriage, etc.
GARLAND KIT for ACIV, **£13**, plus 15/- carriage, etc.

AMPLIFIER ACII (C)

Incorporates volume and tone controls, providing 4 watts output. H.T. and L.T. supplies are from mains transformer. Standard valves throughout. Amplifier wired and tested, **£6/2/6**, plus 5/- carriage.
GARLAND KIT for ACII, **£5/2/6**, plus 5/- carriage.

HIGH-QUALITY AMPLIFIERS (C)

LEAK "Point One" TL12/12 watt, **27 guineas.** LEAK RC/PA/U remote control pre-amplifier, **9 gns.** LEAK "Varislope" pre-amplifier, **12 gns.** ACOUSTICAL QUAD 12-watt Amplifier (including pre-amplifier), **£35.** ROGER'S "WILLIAMSON" AMPLIFIER, **£31.** ROGERS "WILLIAMSON" PA/TC/UNIT, **£10/7/6.** ROGERS "RD BABY DE LUXE" including pre-amplifier, **£18.** ROGERS "JUNIOR DE LUXE" 10 watt, **£26/10/-.** ROGERS "MINOR" 4 watt, **£11.**

TAPEMASTER MAGNET RECORDING HEADS

A new range of high-quality tape recording heads in chromium-plated cases for single hole fixing. All types are designed for half track recording. Senior Record/Playback, 5,000 ohm, **45/-.** Junior Record/Playback, 3,000 ohm, **39/6.** Senior Erase Head, **45/-.** Junior Erase Head, **39/6.**
TAPEMASTER OSCILLATOR UNITS to suit these heads, **45/-.**
TAPEMASTER OSCILLATOR COIL, 10/6.

CONNOISSEUR 3-SPEED TRANSCRIPTION QUALITY GRAMOPHONE MOTOR & TURNTABLE

Full 12in. turntable, 33⅓, 45 and 78 r.p.m. The synchronous motor is virtually vibrationless and suitable for standard, transcription and microgroove recordings. Including P.T., **£23/13/-.**
CONNOISSEUR. Super lightweight pick-up with interchangeable heads for standard or micro-groove recordings, fitted with easily replaceable semi-permanent sapphire. Price complete with two heads, **£10/0/8.**

HIGH QUALITY LOUDSPEAKERS

Suitable for use with reproduction equipment mentionedon this page.
GOODMANS Audiom 60, 12in., **£11/5/-.**
GOODMANS Axiom 150 Mk II, 12in., **£14/3/4.**
WHARFEDALE Bronze 10in., **£5/0/4.**
WHARFEDALE Golden 10in., **£8/6/-.**
WHARFEDALE Golden 10in. CSB, **£9/5/-.**

BROS, Ltd.

I.F. TRANSFORMERS. Small size, 2½in. x 1¼in. x 1in., 13/6 per pair. Made for us by a leading manufacturer.

UNDRILLED CHASSIS. In 20 s.w.g., bright mild steel: Four-sided size 13in. x 7in. x 2½in., 7/6 each; two-sided with two straps, 12in. x 4in. x 2½in., price 3/9 each. Two sided with two straps, size 6 x 5 x 2in., price 2/6 each.

T.R.F. KITS. Three valve and rectifier receiver, in two-tone Walnut veneered cabinet, size, 12in. x 5in. x 7in. Valve line up 6SH7, 6SH7, 6K6, 2xRM2 metal rectifiers. As is usual all main components are supplied mounted on the chassis. Kit includes circuit diagram, but does not include wiring diagram or instructions. Price, £6/17/6 (C).

TWO-GANG TUNING CONDENSERS. Standard size 2-gang of 500pF capacity, with fixing feet. Price 8/6.

BOOKS FOR RADIO ENGINEERS

Mullard Valve and Service Reference Manual	5/-
Mullard Amateurs Guide to Valve Selection	1/6
Osram Valve Manual, Part 1	5/-
Brimar Radio Valve and Teletube Manual	5/-
Wireless World Radio Valve Data, 3rd edition	3/6
Radio Valve Guide. By W. J. May	5/-
The Williamson Amplifier Manual, latest edition	3/6
Wireless World High Quality Amplifier Manual	2/6
T.V. Fault Finding	5/-
Television Faults	5/-
Television Explained (Miller)	5/-
Viewmaster Envelope (state transmitter for which required)	7/6
Tele-King Envelope	6/-
The Oscilloscope Book	5/-
Magnetic Recording (Quartermaine)	4/6

(Add 3d. to price in all cases for postage)

TYANA SOLDERING IRONS. Light weight, 40 watt irons with easily interchangeable elements and 3/16in. diameter bits. Voltage ranges, 100/110 v., 200/220 v. and 230/250 v. Price 16/9. "The iron that makes soldering a pleasure."

ELECTROLYTIC CONDENSER OFFER. 8 mfd. 450 v., 1/9; 8-32 mfd. 475 v., 5/-; 32-32 mfd. 350 v., 4/9; 500 mfd., 15 v., 2/9; 1500 mfd., 6 v., 2/-.

CERAMIC SWITCHES. Single pole, eight-way, 3/6 each.

J.B. SQUAREPLANE DIALS. Printed in two wavebands with station names. 8/1 drive and bronze escutcheon and glass. Price 12/9.

J.B. FULL VISION DIALS. Similar to above but with 7½ x 3½in. dial printed in three wavebands. Price 13/-.

DECALS. 500, ¼in. high white transfer letters and words for marking electronic equipment. Price 4/9 per book.

WIRE WOUND RESISTORS. Open, cement coated or vitreous enamelled. **4 watt,** 21, 50, 90, 100, 200, 1 k. Price 1/- each. **6 watt,** 30, 145, 250, 270, 10 k., 15 k. Price 1/6 each. **10-15 watt,** 5, 90, 100, 120, 170, 175, 200, 250, 400, 500, 600, 700, 750, 950, 1 k., 1,690, 3.5 k., 3.6 k., 4.5 k., 4.7 k., 11 k., 15 k., 20 k., 25 k., 47 k., 50 k., 1/9 each. **15 watt,** 650 ohm. Price 2/-.

ALL GOODS NEW AND UNUSED. **ITEMS (C) REQUIRE CRATING FOR SAFE DESPATCH. CRATES ARE NOT CHARGED PROVIDED YOU UNDERTAKE TO RETURN CARRIAGE PAID TO US.**

PLEASE ADD POST OR CARRIAGE ON ALL ITEMS. KINDLY PRINT NAME AND ADDRESS. POST ORDERS TO OUR DEPTFORD ADDRESS. EARLY CLOSING THURSDAY, OPEN ALL DAY SATURDAY.

CARBON RESISTORS

ONE-THIRD TO ONE-HALF WATT: 10, 13, 15, 22, 33, 39, 56, 68, 71, 73, 100, 150, 170, 180, 220, 250, 270, 330, 390, 400, 450, 470, 500, 530, 600, 680, 820, 1k, 1.2k, 1.5k, 2.2k, 3.3k, 3.9k, 4k, 4.7k, 5.6k, 6.2k, 6.8k, 7.5k, 8.2k, 10k, 12k, 15k, 18k, 20k, 22k, 24k, 25k, 27k, 30k, 33k, 39k, 40k, 47k, 50k, 56k, 100k, 150k, 220k, 270k, 330k, 470k, 680k, 1m, 1.2m, 1.5m, 2m, 2.2m, 2.7m, 3.3m, 4.7m, 10m. All at **4d.** each.

ONE WATT: 50, 56, 82, 120, 150, 240, 330, 290, 680, 1k, 1.5k, 2.2k, 3k, 3.9k, 4.7k, 5.1k, 5.6k, 6.8k, 10k, 12k, 18k, 22k, 24k, 27k, 33k, 68k, 70k, 80k, 170k, 330k, 390k, 470k, 680k, 750k, 1m, 2.2m. All at **6d.** each.

TWO WATT: 220, 1k, 2k, 2.2k, 3k, 3.3k, 4.3k, 4.7k, 6k, 10k, 12k, 20k, 22k, 27k, 30k, 47k, 50k, 68k, 2.2m. All at **9d.**

FOUR WATT: 500k, 1/- each.

L.F. CHOKES. 10 Henry, 70 mA., 5/6 each

PUSH-PULL OUTPUT TRANSFORMERS. Ratio, 45 : 1 to match 6V6 etc., 10,000 ohm to 2 ohm, 4/6 each.

SENSITIVE HIGH RESISTANCE HEADPHONES. 4,000 ohms. Ideal for Tape Recorder Monitoring, A.C. Bridges, etc. 15/- per pair.

LOUDSPEAKERS AT PRE-TAX PRICES

By leading manufacturers. Brand new and fully guaranteed. 5in. p.m. moving coil, 16/6; 8in. p.m. moving coil, 17/6.

SENSITIVE NEONS: 85 v. striking. SBC with centre contact. Ideal for record level indicator on tape recorders, mains indicator, etc., 2/6 each.

HIGH VOLTAGE MICA CONDENSERS 0.1μF 1,500 v. wkg. Bakelite-cased upright mtg., 3in. x 2½in. x 1¾in. overall, 2/- each. Ceramic pot type, 10C/2178, 0.0002μF 5 kv. wkg., high H.F. current, 2/6 each. Flat bakelite-cased type, ZA2837, 0.001μF, 5 kv. A.C. test, 0.5 A. at 2-8 mc.; size 3½in. x 1¾in. x ¾in.; suitable tx or tv, 1/9 each. 0.002μF, 2.5 kv. wkg., 1/3.

METAL RECTIFIERS

Type RM2, 125 v. at 100 mA. Two in series required for mains voltage. Price 4/6 each. Type 14D/972, providing 250 v. 25 mA. when used with a reservoir condenser. Small size ideal for test equipment also in place of 14D/36 in T/V circuits. Price 6/6 each. 6 v. 1 a. half-wave (or full wave with C.T. tfmr.), price 5/- each; 12 v. 1 a. bridge, price 8/6 each; 12 v. 4 a. bridge, price 22/6.

T.R.F. COILS. Medium and long wave, aerial and H.F., 6/- per pair; with reaction winding, 6/9 per pair.

TOROIDAL CERAMIC POTENTIOMETERS. 17k, 100 watt, 8/6.

TOGGLE SWITCHES. SPCO, 250 v. 2 amp. 1/9; DP on-off 250 volt, 1 amp., 2/3.

ENGRAVING TOOL. Operates from 200-240 volt A.C. for engraving on metal and plastic, price, 12/6.

WAFER SWITCHES

For ¼in. dia. spindle. Length of spindle quoted from end of bush.

3p. 2w. ¾in. 1/9.	4p. 3w. miniature 2½in., 3/6.
6w. parallelling ¾in., 1/9.	4p. 3w. ¾in., 1/9.
4p. 2w. miniature ¾in., 1/9.	2p. 4w. 4 bank ¼in., 3/6.
	3p. 3w. 3 bank ¼in., 3/-.

FIXED CONDENSERS: (pF's): Ceramic: 2, 4, 15, 20, 27, 30, 50, 220, 350. All at **9d.** 1,000pF. 1/-. Silver Mica: 10, 30, 50, 160, 170, 180. All at **6d.** 200, 300, 1,500, 8,100, **9d.** Moulded Mica: 50, 75, 100, all at **6d.** 300, 470, 1,000, 2,000, 3,000, 4,000, 4,500, 4,700, 5,000 10,000, all at **9d.**

CLOSE TOLERANCE SILVER MICA CONDENSERS. All plus or minus 1 per cent. 100pF, 400pF, **9d.** each. 1,000pF, 1,400pF, 1/3 each.

MULTI-PURPOSE TOOL. Bends, shears, punches and threads sheet-strip and rod. For all the little workshop jobs that waste your time. Complete with jig, gauge and protractor, enabling repetition work to be carried out with precision, 17/6.

VARLEY MAINS TRANSFORMERS. Primary 10-0-200-220-240 volts. Secondary 300-0-300 volt at 150 mA., 5 volt at 3 amps., 6.3 volt at 4 amps., 6.3 volt at 1 amp. Open type construction. Price 45/-.

SPECIAL TYPE VALVE OFFER. CV1141 (NGT1), 4 v. THYRATRON. Electronic relay for timers, etc. B5 base, 6/6 each CV265 4 v. ½-wave high current rectifier, 10 base, 5/- each. 7193 6.3 v. UHF triode. Plug-in replacement for 6J5G if anode and grid top caps connected to pins 3 and 5. 10 base, 2/6 each. 6SH7 6.3 v. HF pentode. For T/V. amplifiers, receivers, etc. 10 base, 6/6 each. RL18 6.3 v. miniature triode B3G base, 5/- each. 6U5G 6.3 v. magic eye. Ideal for bridges, recorders, etc. 10 base 7/6 each. U22 2 v EHT rectifier for T.V. MO base, 8/6 each.

ROTARY CONVERTER POWER UNITS: Admiralty type W8242. D.C. input 24 v., A.C 50 cycle output 182 v to 306 v. by 12 v. steps selected by switch on built-in auto transformer Moving Coil rectifier type 0-250 v A.C. 2½in meter. Admiralty rating 75 watts. Callers only. Price £6/10/-.

METAL-CASED TUBULAR CONDENSERS. 0.01 mfd. 1 kV., 1/-; 0.02 mfd. 750 v., 9d.; 0.1 mfd. 350 v., 9d.; 0.25 mfd. 500 v., 2/-.

HEATER TRANSFORMERS. Primary 230 v., secondary 6.3 v., 1.5 amp. Wax impregnated, Price 6/- each.

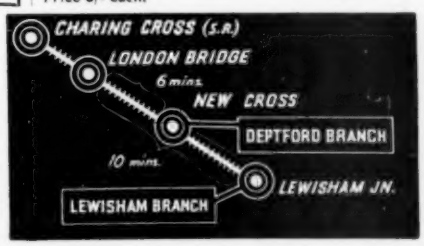
GARLAND BROS, Ltd.

CHESHAM HOUSE, DEPTFORD BROADWAY, S.E.8

Telephone: TIDEWAY 4412/3

5 OBELISK PARADE, LEWISHAM, S.E.13

Telephone: LEE GREEN 4038



BUILD A PROFESSIONAL RADIO OR AMPLIFIER AT LESS THAN HALF TODAY'S PRICE

You're SURE to get it at

STERN'S

ESTABLISHED 25 YEARS

A MIDGET 4-STATION "PRE-SET" RECEIVER

A complete Kit to build a 4-station "Pre-set" Superhet Receiver for A.C. mains operation.

The set is designed to receive any three stations on medium waveband and one on long wave, each station being received by the turn of a rotary switch—no tuning being necessary. It is of midget size, being 8¼in. × 4¼in. × 7in. high, and has the performance of a far more expensive ready-made set, but can be built for half the price. This Receiver, as illustrated, can be completely built for approx. **£9/9/-**. The complete assembly instructions, including component layout and component price list, is available for **1/9**

A MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Set covering medium and long wavebands.

Designed to operate on A.C. mains 200/240 volts, or by an "Alldry" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied (a) as an "Alldry" Battery Superhet Personal Set which can then be accommodated in the attache case as illustrated (size 9½in. × 4½in. × 7in.), this is attractively finished in lizard, maroon, dark green or blue rexine, or (b) as a combined Mains Battery Superhet Portable Receiver, for which a polished wood cabinet is available to accommodate both Mains Unit and Batteries together.

Circuit incorporates delayed A.V.C. and pre-selective Audio Feedback. Kit is complete in every detail and includes ready-wound frame aerials, fully aligned I.F. transfs. and drilled chassis, etc.

Overall size of assembled chassis 8in. × 4in. × 2¾in.

This receiver, as illustrated, can be completely built for approx. **£10** (plus Mains Unit if required). Send **1/9** for the fully descriptive Assembly Book which includes Practical Layouts and complete price list of Components.

The "Wireless World" 3-Valve Set

A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands. We are able to supply all of the components to build this set, as designed and specified in the Feb. 1950 issue, including the drilled chassis. Valves and moving coil speaker, etc., at the following prices:—To construct complete chassis, less dial and drive assembly, **£5/5/-**. Ditto including dial and drive assembly, **£6**. To construct the complete set, including dial and drive assembly and cabinet, **£7/3/6**. Overall size of cabinet is 7½in. × 8½in. × 11½in. A reprint of the designer's article, giving circuit and assembly instructions (this is available separately for **9d.**) together with a practical component layout is included with each of above assemblies.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build Midget "Alldry" Battery Eliminator, giving approx. 69 volts and 1.4 volts. This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T voltage as above, or approx. to 69 volts.

The Kit is quite easily and quickly assembled and is housed in a light aluminium case size 4½in. × 1½in. × 3½in. Price of complete Kit with easy-to-follow assembly instructions, **42/6**.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled unit 7in. × 2½in. × 1½in. Price **47/6**.

THE "MINI-TWIN" 1-VALVE BATTERY SET

A design of a simple 1-valve 2-stage Battery Receiver, giving excellent results on medium and long wavebands and having exceptionally low battery consumption.

Drilled chassis and practical diagrams make it the ideal set for the beginner to build.

The complete chassis, including valve, can be built for **37/6**, the attractive plastic case is **9/6**, and suitable headphones **14/9**.

The complete assembly instructions, layouts and a component price list, are available for **1/6**.

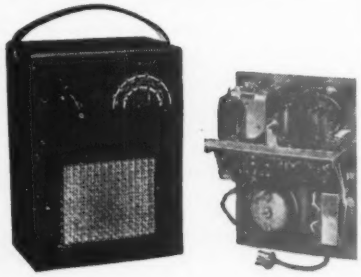
This Receiver also performs excellently, without modification, as a tuning unit, and in addition, with simple modifications for which a complete diagram is provided makes a first-class pre-amplifier for pick-up or microphone.

PICK-UPS

Cosmocord "G.P.20," for standard records, **£3/11/5**; interchangeable (G.P.19) head for L.P. records, **£2/3/4**.
Decca lightweight "turnover head" type, for L.P. and standard records, **£3/19/2**.
Goldring, Standard, lightweight Magnetic, **35/10**.
Cosmocord "Acos" G.P.30, turnover crystal type. For Standard or L.P. Records, **£3/11/5**.

THE "MINI TWO-THREE" BATTERY PORTABLE

An "**Alldry**" Battery Portable of midget size, 6¼in. × 4¼in. × 8¾in., designed to cover medium waveband 190-559 metres, with use of short trailer aerial.



The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made.

Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain output pentode. Valve line up 1T4—1T4—DL94.

The 2-valve set can be completely built for **£4/3/6** (less case), and the 3-valve for **£5/3/-** (less case). Each price includes valves, speaker and drilled chassis.

Send **1/9** for the assembly instructions; they include simple and complete practical component layouts and diagrams, which enable the most inexperienced constructor to successfully build either set. All components are available for separate sale, a price list being supplied with the assembly instructions.

BATTERY CHARGER KITS

All kits incorporate metal rectifiers and are for use on A.C. mains 220-250 volts. All kits include an easily followed wiring diagram.

For charging 6 or 12 volt battery at max. 1½ amps with variable resistor and meter, **£2/4/-**.

For charging 6 or 12 volt battery of max. 2½ amps., less variable resistor and meter, **£2/2/-**.

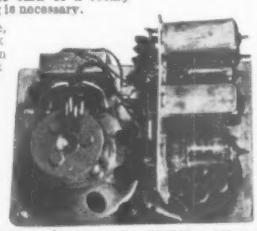
For charging 6 or 12 volt battery at max. 2½ amps, with variable resistor and meter, **£3/8/3**.

THE "WIRELESS WORLD" MIDGET A.C. MAINS 2-VALVE RECEIVER

We can supply all the components to build this set, including valves and moving coil speaker, for **£3/10/-**, including designers' complete building instructions (these are available separately for **9d.**).

THE "PRACTICAL WIRELESS" "MINI FOUR" BATTERY PORTABLE

A 4-valve Battery Superhet Receiver designed to receive 4 pre-set stations, three on medium waveband and one on long wave to suit local conditions. Each station is obtained on the set by the turn of a rotary switch. No tuning is necessary.



It is of midget size, being only 4½in. × 6½in. × 4½in. when completely built and is very easily assembled from diagrams supplied.

Cost of all components to build this set, in accordance with the design, including a drilled and cut chassis and panel and new valves, is **£9/10/-** (or less valves for **£6/7/6**). Attractive carrying case finished in blue leatherette, **16/9**. Complete constructional data with a blueprint, which shows the practical component layout and wiring diagram, together with an individual component price list, is available separately, **1/6**.

Our battery eliminators (illustrated above) available in kit form are suitable for use with this set.

A COMPLETE BATTERY CHARGER

For charging either 2, 4, 6 or 12 volts at 1½ amps. Complete in metal case, and incorporating a limiter resistor. Size 5½in. × 5½in. × 4½in. Complete and ready for use, **52/6**.

AN ELECTRIC TRAIN CONTROL UNIT

Provides 4, 6, 8, 10 or 12 volts 1 amp, and has provision for forward and reverse motion. Complete in metal box. Size 5½in. × 5½in. × 4½in. **53/6**.

DENCO I.F. LINER

For accurately giving 465 Kc. and 1.6 Mc. I.F. channels and associate circuits. Battery operated, small and completely self-contained, **59/6** (plus battery **2/2**).

THE FAMOUS "SHAFTESBURY" RIBBON MIKE

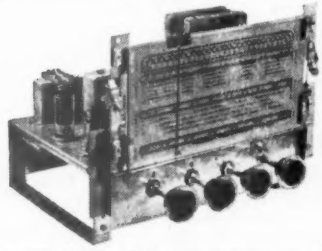
Incorporating internal line transformer having transformation ratio from ribbon impedance up to 500-600 ohms . . . reduced from 10 gns. to **£6**. A special line to grid, 500-600 ohms transformer also available for **25/-**.

Send 9d. for our New FEBRUARY STOCK LIST, it shows hundreds of **RADIO AND TELEVISION COMPONENTS** and many KITS OF PARTS for both Sets and Battery Chargers. When ordering please include approx. cost of Post and Packing.

ALL KITS INCLUDE "EASY TO FOLLOW" POINT-TO-POINT WIRING DIAGRAMS

TWO COMPLETELY ASSEMBLED "ALL-WAVE" SUPERHET CHASSIS

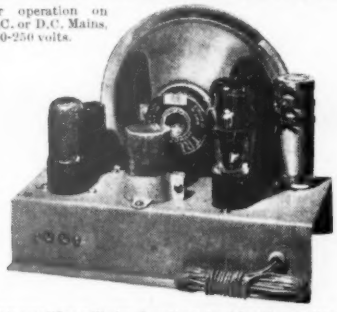
(a) **MODEL B.3.** A 5-valve 3-waveband superhet Receiver. (b) **MODEL B.** A 5-valve 6-waveband (4 bandspread) Superhet Receiver.
Both Receivers are for operation on A.C. mains 100/120 volts and 200/250 volts and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram and radio, making them the ideal replacement chassis for that "old Radiogram," etc.



Brief specifications: **Model B.3.**—valve line up, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage, short 16-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel-type); (3) wave-change and gram; (4) tone (3-position switch operative on gram and radio).
Negative feedback is employed over the entire audio stages. Chassis size 11×7¼×8½in. high. Dial size 9¼in.×4¼in. Price, complete and **READY FOR USE**, excluding speaker, **£12/12/-**. (Carr. and Pkg. 7/6 extra.)
Model B employs a similar valve line up as the **B.3**, but covers 6 wavebands. Short wave 11-16, 16-25, 22-33, 31-46, and 43-120 metres, and medium wave 187-550 metres. The first four short bands are bandspread. The controls employed are as used on the B.3 model, but the tone control operates a six-position switch, having three additional positions for varying bass and treble on gram reproduction. Negative feedback is employed over the entire audio stage. Size of chassis and dial is as given for B.3. Price complete and READY FOR USE, excluding speaker, **£15/15/-**. Carriage, packing and insurance 7/6 extra.

A Complete Kit of Parts to build a 3-4 WATT HIGH GAIN AMPLIFIER

for operation on A.C. or D.C. Mains, 200-250 volts.



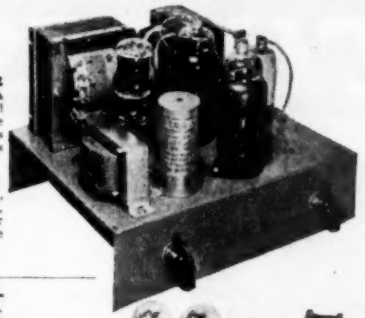
This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.
A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in.×5in.×7in. and valve line up 25Y5-6aH7-25L6.
Price of complete kit including drilled chassis and valves, **£4/2/9**, plus 6½in. P.M. (which fits on chassis), **16/-**, or 8in. P.M., **18/9**.
Price of fully assembled chassis ready for use **£5/5/-** (plus cost of speaker).
Copy of assembly instructions and components price list available for **1/3**.

!! AMPLIFIERS !!

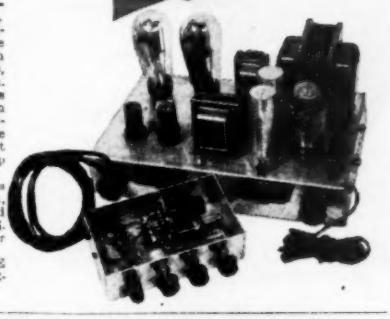
TWO COMPLETE KITS OF PARTS

A 6-8 watt QUALITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, incorporating a simple arrangement to enable either a magnetic-crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers.

The overall size of the assembled chassis is 10in.×8in.×7½in. high, and full practical diagrams are supplied. Price, including drilled chassis and valves, of complete kit, **£6/17/6**. Price of assembled chassis, supplied ready for use, **£8/12/6**. Full descriptive leaflets are available separately for **1/-**.



A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feedback, and comprises a main amplifier chassis and a remote control unit incorporating four controls—bass, treble, main volume or mixing control, and a radio, gram, microphone, selector switch. This control unit measures only 7×4×2in. The measured frequency range of the amplifier with this unit shown an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording.
Input voltage for maximum output is 70 mV., 6.3 volts at 2 amps and 30 mA. H.T. is provided for tuning unit, etc. Price of complete kit, including drilled chassis and valves, **£14/10/-**. Complete specification and layout, **1/6**. We can also supply completely assembled and ready for use at **£16/10/-**.
THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THE COST.

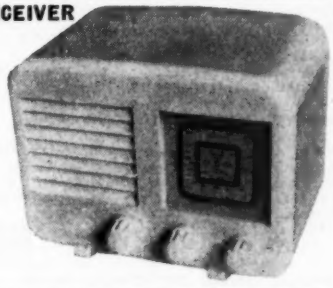


A 5-VALVE "ALL-WAVE" SUPERHET RECEIVER

For use on A.C. Mains 200 to 250 volts.
This small attractive Receiver, embodying modern circuit technique, is designed to cover Short, Medium and Long wavebands, and incorporates the following outstanding features:

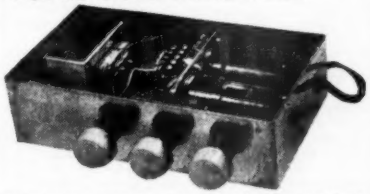
- A superhet circuit designed for high efficiency on all three wavebands.
- A 3½in. P.M. Speaker accurately matched for good quality reproduction.
- The latest range of new 6-volt B.V.A. miniature valves.
- Built-in frame aerial with provision for external aerial for distant stations.
- A white plastic cabinet of very attractive appearance, overall size 7¼in.×5½in.×5¾in.
- THE RECEIVER AS ILLUSTRATED CAN BE BUILT FOR APPROX. **£10/10/-**.

Send 2/6 for the fully descriptive stage by stage assembly and wiring diagrams, with which complete price details are given.



A DUAL CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

This comprehensive PRE-AMPLIFIER and TONE CONTROL UNIT provides a full control of bass and treble in conjunction with a main Volume Mixer Control.



It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English, American and long playing, without recourse to pick-up correction.
The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier.
Response characteristics are given in 12-watt amplifier advt.
The unit measures only 7in.×4in.×2in., including self-contained power supply, and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price, including drilled chassis, valves (6SN7 and 6J5), **£3/16/9**. Complete assembly data is available separately for **1/-**. Completely assembled and ready for use, **£5/5/-**.

A Genuine

SPECIAL OFFER!

PLESSEY 3-SPEED AUTO CHANGE UNITS

Brand New in maker's Cartons, complete with mounting instructions.

£11.19.6

(Normal price is £23/10/-)

- ★ These units will auto change on all three speeds, 7in., 10in and 12in.
- ★ They play MIXED 10in and 12in. records.
- ★ They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- ★ The size of the unit deck is 14in x 11in. with 8in. show deck and 2½in. below.

A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.
Please include 7/6 packing, carriage and insurance.

STERN RADIO Ltd.

109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

The Viewmaster Televisor.—We have had very considerable experience in assisting customers to build this T/V and can supply all SPECIFIED COMPONENTS EX-STOCK. The assembly instructions showing practical layouts and price list are available for **7/6** (or London, Sutton Coldfield, Holme Moss, Kirk-o'-Shotts and Wenvoe. Complete television price list is contained in our general STOCK LIST at **9d.** including Haynes, etc., components.

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Bargains in
EX-SERVICE AND MANUFACTURERS' SURPLUS
RADIO & ELECTRONIC EQUIPMENT

BATTERY POWERED COMMUNICATIONS RECEIVER R1224A

Ref. 10D/13074

Covering the "Trawler Band"

A 5 valve 2/VP23s, 210LF, FC2A, 220PA, 3 wavebands 30-300 metres. IF 470Kcs. SM tuned, Superhet Receiver, headphone outputs.
Complete (less batteries) in wooden cabinet with calibrated chart on hinged lid. Dim.: 14½ x 10 x 9½in., finish grey.
ASK FOR No. X/H355 **£7.19.6** Each CARRIAGE PAID
IN ORIGINAL TRANSIT CASE

R1224A RECEIVER
As above, but less valves. Used, reconditioned and tested.
ASK FOR No X/H355A **£3.19.6** Each CARRIAGE PAID
Batteries required: H.T. 120 V., G.B. 9 V. L.T. 2V.
Circuit of R1224A available, price 1/3.

METAL (MINE) DETECTOR NO.4
Ref. ZA24238
Of Cdn. design and construction, using IT4 pentodes. Comprising TC. Amplifier, Search Coil, Sweep Pole, Control Box. Headphones, Test Unit and Ruck sack. Complete less batteries in fitted transit case.
ASK FOR No. X/H179 **£6.19.6** CARRIAGE PAID

METAL (MINE) DETECTOR NO.3
In Original Transit Case Ref.: ZA.22755/1. Of British design and construction.
Comprises: A 3-valve AF Amplifier (ARP.12's= VP.23 Mazda), with space for dry batteries (not supplied) in metal box dim.: 10¼ x 10¾ x 3½in., with lead terminating in 7-way cable socket, contained in a carrying satchel, with high resistance headphones.
Search coil, ZA.22175 or Equivalent, surface area 14½ x 10in.
Search Coil Pole, comprising: Control Box Pole and pivot-eye assembly. Pole (rear section) and Counter-weight assy.
Small Probe, Surface area 9 x 5½in.
The whole contained in original fitted transit case, dim.: 52½ x 14 x 10½in. Weight: Approx. 76 lbs.
ASK FOR No. X/H856 **£8.19.6** CARRIAGE Each PAID
Power Requirements, Dry batteries. L.T. 6 Type "S" 1½ volts cell. H.T. 60-90 volts.

THE R1155 AS A COMMUNICATIONS RECEIVER WITH 9 VALVES FOR 200-250 VOLTS A.C. MAINS.
Comprises:—RECEIVER UNIT R1155 WITH:— 5 Switched Bands, 18-7.5 mcs. = 17-40 metres 7.5-3 mcs. = 40-100 metres. 1,500-600 kcs. = 200-500 metres. 500-200 kcs. = 600-1,500 metres. 200-75 kcs. = 1,500-4,000 metres.
7 Valves: VR99 (X65). 3/VR100 (KTW61). 2/VR101 (DH63). VR103 (Y.63) ME: DF Valves left out.
Simple controls. Slow motion 2 speed Tuning Manual Volume Control. Wave Change Switch. Also optional B.F.O., A.V.C., Magic Eye Tuning Indicator. In black metal case 16½ x 9 x 9in.
Plus:— COMBINED OUTPUT/POWER PACK with 2 valves, Pentode Output and Rectifier 8in. Speaker, Mains and output transformers, Tone Control, On/Off Switch. In black crackle metal case, 16½ x 9 x 9in.
ASK FOR No. X/E6A **£18.10.0** CARRIAGE PAID
A few only: R1155-N Model.
Range: 18-1.5 mcs., 1500-600/500-200 kcs.
ASK FOR No. X/H481 **£18.18.0** CARRIAGE PAID
Or with combined Output/Power Pack at **£26/19/6.**

R1155, R1155A, RECEIVER UNITS USED, fully reconditioned and tested (complete, less power pack) **limited quantity only.**
ASK FOR No. X/H898 **£7.19.6** Each CARRIAGE PAID

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VENT-AXIA 6in. FAN. REF.: 5A/2905
Moulded Plastic Fan housing assembly 7¾in. dia. (Max.) 8in. long, made in two interlocking sections for mounting in a circular aperture, and completely self-contained, mounted on metal frame 17½ x 8¾in. With suppressor unit 5C/870, input through 2P. Chassis Plug.
IN TRANSIT CASE.
ASK FOR No. X/H869 **£3.19.6** Each CARRIAGE PAID

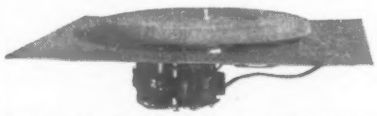
AS ABOVE USED CONDITION
ASK FOR No. X/H869A **£2.19.6** Each CARRIAGE PAID

STARTER MOTOR Type CA4750
Heavy Duty 24 Volts Starter Motor, as used in Aircraft, with recessed splined spindle and mounting by 6 Bolts, Dim.: 8¼in. long, 4¼in. dia.
ASK FOR No. X/H870 **21/-** Each CARRIAGE PAID

F24 AIRCRAFT CAMERA, complete with lens

and suitable for hand or electric use. Takes 5¼in. width film, picture size 5½ x 5¼in. A precision air survey camera. Could be used for laboratory, industrial or portraiture. Focal plane shutter. 12 or 24 volt.
With f/2.9-8in. lens.
ASK FOR No. X/H300 **£9.19.6** Each.
With f/4-5in. lens.
ASK FOR No. X/H302 **£7.19.6** Each.
In fitted transit case. Carriage paid.

A.C. MAINS 200/250 VOLTS, GRAMOPHONE MOTOR



Fitted with 9in. Turntable and Electrostatic Screen, mounted on a metal plate, approx. 14½ x 14in.
ASK FOR No. X/H319 **67/6** Each POST PAID

FOR INEXPENSIVE TELEVISION

IF/AF AMPLIFIER UNIT R.1355
IN ORIGINAL CASE
ASK FOR No. X/E770 **47/6** CARRIAGE PAID
2nd Grade in Transit Case, **42/6** CARR. PAID
3rd Grade, loose stored, **35/-** CARR. PAID
Circuit of R1355 available at 1/3.

R3170A RECEIVER UNIT
ASK FOR No. X/H492 **£4.12.6** CARRIAGE PAID

R3601 RECEIVER UNIT
ASK FOR No. X/H493 **£4.12.6** CARRIAGE PAID

INDICATOR UNIT TYPE 6A in Transit Case Containing a VCR97 Cathode-ray Tube, with mu-metal screen, 4/VR91s (EF50), 3/VR54s (EB34), various w.w. pots, switches, H.V. conds., resistors, etc., built in metal chassis to fit into metal box 18 x 8½ x 7½in. All controls are brought to front panel beside viewing screen.
ASK FOR No. X/H887 **£4.9.6** CARRIAGE PAID

TRANSFORMERS
E.H.T. **55/-, 57/6, 59/6** or **65/-** each.
Mains (Morley), **55/-**. (Argus,) **69/6** each.

INDICATOR UNIT TYPE 62
In Maker's original case.
ASK FOR No. X/H526 **£5.9.6** CARRIAGE PAID
Also available, used, good, condition.
ASK FOR No. X/H774 **79/6** CARRIAGE PAID

INDICATOR UNIT TYPE 62A
Used, good condition.
ASK FOR No. X/H868 **£7.19.6** CARRIAGE PAID

5 CPI CATHODE RAY TUBE
ASK FOR No. X/H529 **35/-** POST PAID

CLYDESDALE SUPPLY CO. LTD.,
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"MUST HAVE" BARGAINS!

10 VALVE 1½ METRE SUPERHET ZC 8931. For long distance TV results. Valve line up is 6 of VR 65, 2 of VR 92, and 1 each VR 136 and VR 137, and the 12 mcs. 6 stage I.F. Strip gives tremendous amplification with ample bandwidth of 4 mcs. Easily modified. Full details supplied. ONLY **59/6** (carriage etc. 5/-).

RECEIVER R.3118. An A.C. Mains operated version of the above ZC 8931, but is infinitely more powerful, having another I.F. stage and employing 16 valves ; 6 of VR 65, 4 of VR 92, 2 of VR 136, and 1 each VR 137, P 61, 5Z4 and Y 63 "Magic Eye." Built in power pack operates from 180-240 volts A.C. In excellent condition. ONLY **97/6** (carriage etc. 7/6).

194 I.F. STRIP. An easily modified I.F. Strip recommended for TV constructors who want good results at moderate cost, or for those who have built televisors but are having trouble in the vision or sound receivers. Can also be modified for 2 channel working as per details in "Practical Television" October issue. This 6 stage strip measures 18in. x 5in. x 5in., and contains 6 valves VR 65, 1 VR 92 and 1 of VR 56 or VR 53. Mod. data supplied. ONLY **45/-** (postage etc. 2/6).

208 AMPLIFIER. Ideal for conversion into a high gain TV pre-amp. Complete with 2 valves EF 50. ONLY **15/-** (postage etc. 1/6).

HIGH RESISTANCE PHONES. A pair of ex-R.A.F. 3,000 ohm phones fitted with chamois leather noise excluding earpieces, and jack plug. BRAND NEW . ONLY **15/-** (postage etc. 1/6).

6in. MAGNIFYING LENS FOR VCR 97 TUBE. First grade oil filled. ONLY **25/-** (postage etc. 2/-).

CERAMIC 2 WAY 3 BANK SWITCHES, 7/6 each.

CHOKES. 10 H. 60 ma., **3/9** ; 30 H. 100 ma., **12/6** ; 5 H. 200 ma., **6/-** (postage 1/- per choke).

CHASSIS OF POWER UNIT 529. An ideal unit for stripping, or for using to build an amplifier etc. Contains valveholders, resistors, potentiometer, chokes, and block and tubular condensers. Brand new, and housed in grey metal case size 12in. x 8½in. x 7½in. ONLY **10/-** (carriage etc. 3/6).

COMMUNICATIONS RECEIVER R.1155

The famous ex-Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges 18.5-7.5 mcs, 7.5-3.0 mcs, 1,500-600 kcs, 500-200 kcs, 200-75 kcs, and is easily and simply adapted for normal mains use, full details being supplied. Aerial tested before despatch these are BRAND NEW AND UNUSED IN MAKERS ORIGINAL TRANSIT CASES, ONLY **£11/19/6.**

A few used receivers, also tested working before despatch, are available at **£7/19/6.**

A factory made Power Pack, Output Stage and Speaker, contained in a black crackled cabinet to match the receiver, can be supplied at ONLY **£5/10/-.** Operates receiver immediately.

DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

Please add carriage costs of 10/6 for receiver, and 5/- for power pack.

RF UNITS TYPE 26 and 27

The very popular variable tuning units, which use 2 valves EF 54 and 1 EC 52. Type 26 covers 65-50 mcs. (5-6 metres), and Type 27 covers 85-65 mcs. (3.5-5 metres). BRAND NEW IN MAKERS CARTONS. ONLY **59/6.** each.

VIBRATOR UNITS

2 volt type, American made, delivers 67 volts at 4.7 ma 130 volts at 20 ma., and 1.4 v. L.T. Easily adapted for use with any battery receiver, full details being supplied. ONLY **50/-** (postage 2/-).

6 volt type, made by The National Co. of America for use with HRO Communication Receivers, supplying 165 volts at 85 ma. fully smoothed D.C. Complete with vibrator and 6X5 rectifier in black crackle cabinet, size 7in. x 7½in. x 6in. BRAND NEW IN MAKERS CARTONS with full operating instructions, ONLY **52/6.**

12 volt type, made by Masteradio for the Admiralty. Delivers 300 volts at 100 ma., and are complete ready for use. BRAND NEW IN MAKERS CARTONS, ONLY **35/-** (postage etc. 2/6).

MOVING COIL METERS

(BRAND NEW)

50 Microamps 2in. Circular **45/-** ; 50 Microamps 2½in. Circular **70/-** ; 100 Microamps 2½in. Circular **39/6** ; 500 Microamps 2in. Circular **17/6**; 500 Milliamps Thermo 2in. Circular **7/6** ; 500 Milliamps Thermo 2in. Square **7/6.** 100 Milliamps 2½in. Circular **17/6** ; 20 Amps 2in. Circular **7/6** ; 40 Amps 2in. Circular, **7/6.**

6 VOLT BATTERIES

By famous American makers, these have genuine hard rubber cases, and are BRAND NEW AND UNUSED IN MAKERS PACKING. Size 8½in. long x 6½in. wide x 7½in. high. ONLY **59/6** (carriage etc. 7/6).

TRANSFORMERS. Manufactured to our specification and fully guaranteed. Upright mounting, fully shrouded, normal primaries 425-0-425 v. 200 ma, 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a., 0-2-4-6.3 v. 3 a., **72/6.**

425-0-425 v. 200 ma., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a., **50/-.**

350-0-350 v. 160 ma., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a., **42/6.**

250-0-250 v. 100 ma., 6.3 v. 6 a., 5 v. 3 a., **32/6.**

Please add 1/6 per transformer postage.

TRANSFORMERS, FILAMENT.

6.3 v. 2 a., **7/6.**

6.3 v. 3 a., **10/6.**

(Postage 1/-).

TRANSFORMERS EHT. Upright mounting. EHT for VCR 97 tube, 2,500 v. 5 ma., 2-0-2 v. 1.1 a., 2-0-2 v. 2 a., **37/6.**

EHT 5,500 v. 5 ma., 2 v. 1 a., 2 v. 1 a., **72/6.**

EHT 7,000 v. 5 ma., 4 v. 1 a., **82/6.**

Please add 1/6 per transformer postage.

TRANSFORMERS, EX-W.D. & ADMIRALTY. Built to more than 50% safety factor, with normal A.C. Mains Primaries. All brand new and unused.

330-0-330 v. 100 ma., 4 v. 3 a. Weight 7 lbs. (postage 1/6), **22/6.**

L.T. 5-0-5 v. 5 a., 5 v.-0-5 v. 5 a., 5 v.-0-5 v. 5 a. By using combination of windings will give various voltages at high current. Weight 11 lbs. (postage 2/6), **35/-.**

L.T. 6.3 v. 7.7 a., 4.2 v. 2.5 a., 4 v. 1 a. (postage 1/6), **19/6.**

EHT 1,400 v. 2 ma., 520 v. 10 ma., 300 v. 10 ma., 2 v. 1.5 a. (postage 1/6), **21/-.**

SPECIAL OFFER. 300-0-300 v. 200 ma., 5 v. 3 a., 6.3 v. 5 a. C.T., 20 v. 750 ma., 70 v. 100 ma. Still in makers cartons, unused, but have become damaged. They are still usable, the damage being broken fixing lugs, and/or broken bakelite terminal panels. Formerly sold at 42/6, now offered at **25/-** (post 2/6).

GERMANIUM CRYSTAL DIODES. 4/6.

GANGED POTENTIOMETERS. Double 50K and Double 1 Meg., **7/6** each.

Cash with order please, and print name and address clearly. Amounts given for carriage refer to inland only.

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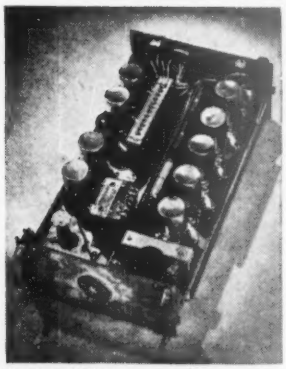

PYE 45 Mc/s STRIP. Special purchase of M.O.S. Type 3583 Units. Size 15in.×8in.×2in. Complete with 45 Mc/s Pye Strip, 12 valves, 10 EF59, EB34, and EA50, volume controls and hosts of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price £5, carriage paid.

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2½in. Plessey, less Trans.	14/-
3½in. Elac, less Trans.	15/-
5in. Plessey, less trans.	12/6
5in. Rola, with Trans.	16/-
10in. Electrona, with Trans.	25/-
10in. Rola, with Trans.	30/-
10in. Goodmans, with Trans.	30/-

WELWYN WIRE-WOUND SLIDER RESISTORS

MOUNTED ON PANEL FOR T/V SETS.

4 Bank: 100Ω, 500Ω, 2-10 k.	5/-
4 Bank: 1K, 2-2K, 1-1 meg. (car)	5/-
5 Bank: 200Ω, 2K, 3-10K	6/-

W/W. PRE-SET VOLUME CONTROLS TYPE "901"

100Ω, 500Ω, 2K, 5K, 10K and 30K ..... each 2/6

MUIRHEAD VERNIER DRIVES 10/6 or with Skirt 12/6

CONDENSERS. Electrolytic 8 mfd. 450 vw., 2/6; 8×8 mfd., 4/-; 16 mfd. 450 vw. 3/6; 16×16 mfd. 450 vw., 5/-. All midget tubular cans, cardboard sleeves 60 mfd., 40 mfd. 350 vw., size 4¼in.×1in. Bias condensers 25×25 mfd., 50×12, 12×50, 1/6; 50×50, 2/-. All new stocks. NOT surplus.

BOWTHORPE CONTINUITY METER. Dual scale 0-500 ohms and 100-200,000 ohms moving coil operated from 4½-volt internal battery. Size 6in.×3in.×4in. Original price £8/19/-. Our price, brand new, £4/4/-.

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0-5 mA square panel mounting, 2in. scale	7 6
0-50 mA square panel mounting, 2in. scale	7 6
0-40 v. square panel mounting, 2in. scale	7 6
0-20 amps square panel mounting, 2in. scale	7 6
0-300 v. square panel mounting, 2in. scale	12 6
0-40/120 mA double reading round scale	12 6
2½in. round flush mtd., drilled flange:—	
Range 0/750 v. 200 ohms per v. Each	£1 2 6
Range 0/1500 v. 250 ohms per v. Each	£1 2 6
Range 0/3000 v. 200 ohms per v. Each	£1 5 0
0-1 mA desk type, 2½in. scale	£1 7 6

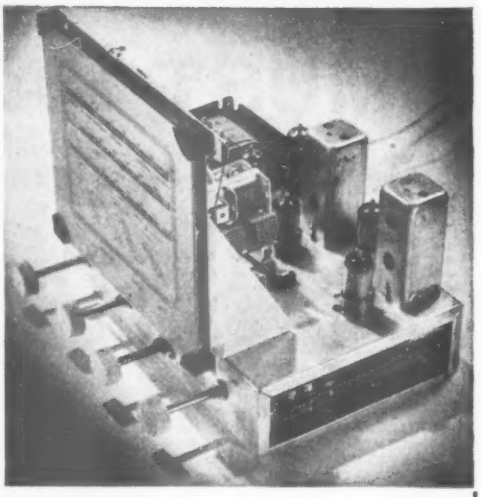
L.T. RECTIFIERS

6 v. 1 amp G.E.C.	4 0
12 v. 2½ amp Westinghouse	12 6
12 v. 4 amp S.T.C.	17 6
12 v. 8 amp S.T.C.	£1 12 6

SEND STAMPS FOR NEW 1953 28-PAGE CATA-LOGUE

RADIO-GRAM CHASSIS

3 Wave-band Superhet Medium, long and short.



5 Latest Type Mullard Valves. 4 Position Switching Gram., med., long and short. Also provision for Extension Speaker. A.C. Mains. 110/250 volts. Chassis 11"×7"×2½" Scale 8" Square.

PRICE **£10 . 19 . 6** BRAND NEW AND GUARANTEED. CARR., PACKING AND INS. 15/-.

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K3/25, 650 v. 1 mA	4 7
K3/40, 1,000 v. 1 mA	6 0
K3/100, 3,500 v. 1 mA	14 8
K3/200, 10,000 v. 1 mA	£1 6 0

H.T. RECTIFIERS

S.T.C. 125 v. 60 mA	4 6
S.T.C. 125 v. 100 mA	5 0
S.T.C. 125 v. 125 mA	6 0
S.T.C. 250 v. 250 mA	18 0

WESTINGHOUSE 14D 972

250 v. 25 mA	6 6
S.T.C. M1/3 Noise Limiter	2 0

G.E.C. METER RECTIFIER, 1 mA .. 11 6

WEARITE

705 Coil Pack 3 waveband	£1 17 10
501 and 502 465 kc. pair	10 0
W/W. Mains Trans. Input 110/250 volts, output 325-0-325 80 mA, 6.3 v. 2.5 amps, 5 v. 2 amps	£1 1 0

RECEIVER R1355. As specified for "Inexpensive Television." Complete with 8 valves VR65 and 1 each 5U4G, VU120, VB92. Only 55/-, carriage 7/6. Brand new in original packing case.
RF24, 25/-; RF25, 25/-; RF26, 59/6; RF27, 59/6.

CATHODE RAY TUBES:
VCR97. Guaranteed full picture. 40/-, carr. 5/-.
VCR517. Guaranteed full picture. 40/-, carr. 5/-.
Mu-Metal Screens for above, 12/6. P.P. 1/3.
3BP1. Suitable for 'scopes. 25/-, carr. 3/-.

RECEIVER UNIT TYPE 159. Size 8in.×6½in.×4½in., containing VR91, VR92, CV66, VR65 and 24 v. selector switch. New condition, 15/-.

9in. ESCUTCHEON. Brown bakelite. Suitable plate glass and mask for 9in. tube. Price 7/6 each.

E.H.T. TRANSFORMER for VCR97. Input 230 v., output 2,500 v. 4 v. 2-0-2, 45/-.

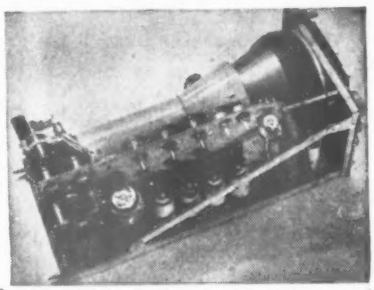
WALKIE-TALKIE TYPE "46," complete with 6 valves. 2VP23, HL23, DD, QP25, TP25 and ATP4 aerial rods, I.F. trans., 1.6 mc/s. mike trans. in new condition, but less transmitting components and coils removed by M.O.S., 35/-, carr. paid. (Less valves, 12/6.)

VR91 (EF50). Red Sylvanian. Brand new original boxes U.S.A., 10/-; Silver, brand new original boxes, British, 8/6; red or silver ex-units guaranteed, 6/-; 6A7, 12/6; 43, 12/6; VU111, VU120, VU120A, at 5/-. Ten EF50 (ex brand new units). 55/-.
WE STOCK ALL TYPES OF STANDARD CATHODE RAY TUBES AND VALVES.

E.H.T. TRANSFORMER for 5CP1. Input 230 v., output 3,250 v. 6.3 v. @ .6 amp, 2-0-2 v., 45/-.

EXPORT ONLY

4,000 prs. DL..R. No. 5. 500 Brand New TR1196 Trans./Rec. in transit cases. 100 Trans./Rec. Type "46" with crystals and accessories. In canvas bags. 750 Walkie Talkies "38" with accessories. Large stocks of transmitting and special-purpose valves. Compass Units DR1A, brand new.



INDICATOR UNIT TYPE 182A. This unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-metal screen, 3 EF50, 4 SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of television (full picture guaranteed) or Oscilloscope. 'Scope constructional circuit include Offered BRAND NEW (less relay) in original packing case at 79/6. Plus 7/6 carr.
SPECIAL NOTE.—The VCR517 Tube has proved to be far superior to the VCR97 Tube (call for demonstration).

VIBRATOR PACKS

Input 6 v., Output 200 v., 60 mA	20/-
Input 6 v., Output 150 v., 40 mA	25/-
Input 6 v., Output 180 v., 40 mA (ex. 21 set)	17/6
Input 2 v., Output 180 v./90 v., 35 mA, 1.4 v., 250 mA	50/-
Input 6 v., Output 290 v., 80 mA (Masteradio)	25/-
Input 12 v., Output 300 v., 100 mA	30/-
6 v. Vib Trans. 250 v., 80 mA	7/6

STROBE UNITS. Brand New, in sealed cartons, these contain 6 EF50s, 5 EA50s, 1 SP61, a host of condensers, resistors, transformers, chokes, relays, switches 7 pots and 5 smoothing condensers. Size 18in.×8¼in.×7¼in. Only 67/6, plus 5/- carriage.

No. 38 "WALKIE-TALKIE" TRANS-RECEIVER, complete with throat mike, phones, Junction Box and aerial rods in canvas bag. Freq. range 7.4 to 9 Mc/s. All units are as new and tested before dispatch. As supplied to Overseas police forces. £4/19/6. Carriage 2/6.

TUNING CONDENSERS

2 gang .0005 standard ¼ spindle, with trimmers	7 6
3 gang .00005 with ceramic insulation ¼ spindle	7 6
Midget two gang, .000375, with trimmers. Size 2in.×1¼in.×1¼in.	6 6
Midget .0005 mfd. 2 gang tuning condenser. Size only 2¼in.×1¼in.×1¼in.	5 0
Or with built-in trimmers	6 6
Two-gang Midget, .0005 with 4-way push-button assembly. Suitable for car radio, etc.	8 6

PLEASE ADD POSTAGE. ARTICLES UP TO 10/-, 1/-. £1, 1/6. £2, 2/-.

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/- extra under £1, 1/6 extra under £3.

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FULL PRICE LIST 5d.
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Please enclose S.A.E. with all enquiries.

SPECIAL OFFERS. Midget Mains Transformers (size approx. 2¼×3×2¼in.). Drop-through chassis type. Screened Primary 220/240 v. 50 c/s. Output: 250-0-250 v. 60 mA., 6.3 v. 2.5 a. Only **10/9.** Small Filament Transformers, 220/240 v. input, 6.3 v. 1.5 a. output, **5/9.** Auto Transformers (with separate l.t. 6.3 v. 1.5 a.), 0-110-200-210, 230-250 v. 50 watts, **4/9** each. New Boxed Ex-Govt. Valves, VR126 (4 v. 7-pin H.F. Pentode), **1/9** each.

BATTERY SET CONVERTER KITS. All parts for converting any type of Battery receiver to All Mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed h.t. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed l.t. of 2 v. at up to 1 a. Price complete with circuit, only **47/9.**

PERSONAL SET BATTERY SUPERSEDER KIT complete with case. Supplies 90 v. 10 mA. and 1.4 v. 250 mA. fully smoothed, from normal 200-250 v. 50 c/s Mains. Price with circuit **29/6.**

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Consists of h.t. and l.t. transformer, h.t. and l.t. rectifiers, smoothing electrolytic, and choke, adjustable charger resistor and case. For Mains input of 200-250 v. Output 120 v. 40 mA. and 2 v. ½ a. Price with circuit, **29/6.**

H.T. ELIMINATOR KIT. Consisting of Mains Transformer (200-250 v. input), smoothing choke, metal rectifier, 32-32 mfd. smoothing Elect., Tapped Dropper Resistor and circuit. Price **21/9.**

BATTERY CHARGER KITS
To charge 6 v. acc. at 1 amp, **19/6.**
To charge 6 or 12 v. acc. at 2 a., **29/6.**
To charge 6 or 12 v. acc. at 4½ a., **45/-.**
Above consists of transformer, full wave rectifier, fuse, fuseholder, metal case and circuit.

SELENIUM RECTIFIERS. 230 v. 50 mA., H.W. (small), **6/9.** 120 v. 40 mA., H.W. (small), **4/6.** 12-15 v. 2 a. F.W. Bridge, **10/9.** 12-15 v. 4 a., F.W. Bridge, **18/9.**

ELECTROLYTICS (Current production. Not ex-Govt.).

Tubular Types		Can Types	
8μF 450 v.	1/11	16μF 450 v.	2/9
8μF 500 v.	2/9	24μF 350 v.	2/11
16μF 350 v.	2/3	32μF 350 v.	2/11
16μF 450 v.	2/9	40μF 450 v.	4/9
16μF 500 v.	3/9	50μF 350 v.	4/9
24μF 350 v.	3/3	8-8μF 350 v.	3/9
32μF 350 v.	3/9	8-8μF 450 v.	3/11
8-16μF 500 v.	4/11	8-16μF 450 v.	4/6
25μF 25 v.	1/3	16-16μF 450 v.	4/11
25-25μF 25 v.	1/9	16-16mfd. 500 v.	5/9
50μF 12 v.	1/3	16-32μF 350 v.	4/9
25μF 50 v.	1/9	32-32μF 350 v.	4/9
50μF 50 v.	2/3	32-32μF 450 v.	5/11
250μF 12 v.	10d.	50-50μ350μF	5/11
		3,000mfd. 6 v.	6/9

CAN TYPES

32-32-8μF 350 v. (Small)	5/11
16-16-8μF 475 v.	5/9
16-16μF 450 v. plus 20μF 25 v.	5/3
32-32μF 350 v. plus 25μF 25 v.	5/11
50μF 350 v. plus 250μF 12 v.	4/11

CHASSIS. (16 s.w.g. Undrilled Aluminium) Receiver type. 6×3½×1½in., **1/11**; 7¼×4½×2in., **2/9**; 16 s.w.g. 10×5½×2in., **3/9**; 11×6×2½in., **4/3**; 12×8×2½in., **5/3**; 16×8×2½in., **7/6**; 20×8×2½in., **8/11**; Amplifier Type, 12×8×2½in., **7/11**; 16×8×2½in., **10/11**; 14×10×3in., **12/6**; 20×8×2½in., **13/6.**

SILVER MICA CONDENSERS. 5μμF, 10μμF, 15μμF, 20μμF, 25μμF, 30μμF, 35μμF, 50μμF, 120μμF, 150μμF, 180μμF, 200μμF, 230μμF, 300μμF, 330μμF, 400μμF, 470μμF, 500μμF, 1,000μμF (.001μF), 2,200μμF (.0022μF). All at **5d.** each. **3/9** dozen one type.

TUBULAR WIRE-ENDED CAPACITORS (New Stock). .001μF 750 v., .01μF 750 v., .02μF 1,500 v. (large), .02mfd. 500 v., .05μF 350 v., .1μF 350 v., .25μF 350 v., .5μF 400 v. All at **4d.** each, **3/3** dozen one type, **27/6** gross.

BAKELITE (Brown or White) and **WOOD** (Walnut veneered) **CABINETS.** Size approx. 12×6½×5in. Very attractive appearance. For illustration see our List. Supplied complete with fully punched T.R.F. 3-valve Chassis, back, 2 or 3 wave. Glass scale with coloured station names. Dial Backplate, **25/-**, plus Carr. 2/6.
All parts available for construction of T.R.F. or Superhet Receiver in above cabinets.

CLEARANCE LINES. ·0005μF 2-gangs with short spindle, **4/6.** Vol. Controls, 1 Meg., with S.P. switch and long spindle, **2/9.** 25K with D.P. switch and 1in. spindle. **2/9.**

VOLUME CONTROLS with long spindles, all values less switch **2/9**, with S.P. switch **3/11.** **WIRE WOUND POTS.:** 5K, 10K, 20K, 25K, 50K (medium length spindles), **2/9.**

FOR CALLERS ONLY. Mains Trans., drop-through type with top shroud. Primary 230-250 v. Secs. 425-0-425 v., 200 mA., 300-0-300 v. 100 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a., **29/9.**

COAXIAL CABLE, 75 ohms, ¼in., **10d.** yard.

DIAL BULBS, M.E.S., 6.5 v. 0.15 a., 8 v. 0.15 a., **6/9** dozen.

VALVE SCREENING CANS. International Octal 3 piece, B7G (Button Base) 2 piece **10/6** doz., **1/3** each.

EX-GOVT. ITEMS. Pye coaxial plugs and sockets **7/6** doz. prs. Belling-Lee moulded type 5-pin plugs and sockets, **1/11** pr. .02 mfd. 5,000 v. Tubulars, **1/9.**

EX-GOVT. SMOOTHING CHOKES
Potted Types

330 mA. 5 H. 50 ohms	12/9
220 mA. 5 H. 50 ohms	10/9
150 mA. 10 H. 200 ohms	10/6
50 mA. 50 H. 1,250 ohms	8/11

EX-GOVT. BLOCK PAPER MANSBRIDGE TYPE CONDENSERS

4μF 500 v.	2/9
8μF 500 v.	4/9

P.M. SPEAKERS. All 2-3 ohms, 5in. Plessey, **13/9**, 5in. Goodmans, **14/9**, 6½in. Elac, **14/11**, 6½in. Plessey with Pentode Trans., **14/11**, 6½in. Goodmans, **16/9**, 8in. Plessey, **15/9**, 10in. Goodmans, **31/-**, 10in. Plessey, **18/6.**

M.E. SPEAKERS. All 2-3 ohms, 4in. E.M.I with trans. Field 700 ohms **14/9**, 6½in. Rola field 700 ohms **11/9**, 8in. R.A. field 600 ohms **12/9**, 10in. R.A. field 600 ohms **23/9.**

COLLARO TAPE DESK MOTORS, shaded pole type, clockwise or anti-clockwise, **29/9** each.

R.S.C. MAINS TRANSFORMERS

Fully Guaranteed. Interleaved and Impregnated.
Primaries 200-230-250 V. 50 c/s Screened.

TOP SHROUDED, DROP THROUGH

260-0-260 v. 70 mA., 6.3 v. 3 a., 5 v. 2 a.	14/11
260-0-260 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	14/11
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	16/8
350-0-350 v. 90 mA., 6.3 v. 3 a., 5 v. 2 a.	21/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v.-4 v., 4 a., c.t. 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t. 0-4-5 v. 3 a.	23/9
350-0-350 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	28/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/11
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	29/11

FULLY SHROUDED UPRIGHT

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type 2¼-3-3in.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for 1355 conversion	29/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a.	45/9
350-0-350 v. 250 mA., 6.3 v. 6 a., 4 v. 8 a., 0-2-6 v. 2 a., 4 v. 3 a. for Electronic Eng. Televisor	67/6
425-0-425 v. 200 mA., 6.3 v.-4 v. 4 a. c.t., 6.3 v.-4 a., c.t., 0-4-5 v. 3 a., suitable Williamson Amplifier, etc.	51/-
425-0-425 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	65/6
325-0-325 v. 20 mA., 6.3 v. 0.5 a., 6.3 v. 1.5 a. for Williamson Preamplifier	17/6

FILAMENT TRANSFORMERS
All with 200-250 v. 50 c/s. primaries: 6.3 v. 2 a., **7/6**; 0-4-6.3 v. 2 a., **7/9**; 12 v. 1 a., **7/11**; 6.3 v. 3 a., **10/11**; 6.3 v. 6 a., **17/6**; 0-2-4-5-6.3 v. 4 a., **16/9**; 12 v. 3 a. or 24 v. 1.5 a., **17/6**; 0-5-6.3 v. 5 a., four times, giving up to 24 v. 5 a. up to 12-6 v. 10 a., up to 6.3 v. 20 a. by series or parallel connections, **55/-.**

CLAMPED UPRIGHT MOUNTING

300-0-300 v. 100 mA., 6-3 v. 3 a., 5 v. 3 a.	21/9
350-0-350 v. 100 mA., 6.3 v. 3 a., 5 v. 2 a.	21/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1.5 a., **14/9**; 0-9-15 v. 3 a., **16/9**; 0-9-15 v. 6 a., **22/9**; 0-4-9-15-24 v. 3 a., **22/9**; 0-9-15-30 v. 3 a., **23/9.**

SMOOTHING CHOKES

250 mA., 8-10 H., weight 12 lb.	16/9
250 mA., 3 H. 50 ohms	8/9
100 mA., 10 H. 200 ohms	7/6
80 mA., 10 H. 350 ohms	5/6
60 mA., 10 H. 400 ohms	4/11
50 mA., 50 H. 1,000 ohms	9/11
1 A., .25 H. l.t. type	4/9

ELIMINATOR TRANSFORMERS

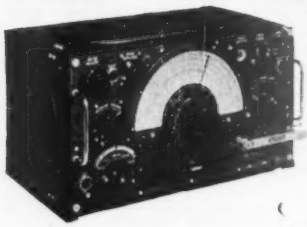
Primaries 200-250 v. 50 c/s., 120 v. 40 mA.	7/11
90 v. 10 mA., 9-0-9 v. 250 mA.	10/6
120 v. 40 mA., 6 v. 1.5 a.	14/9
120 v. 40 mA., 6-0-6 v. 1.5 a.	15/9
E.H.T. TRANSFORMERS. 2,500 v. 5 mA., 2-0-2 v., 1.1 a., 2-0-2 v. 1.1 a., for VCR97, etc.	37/6
4,000 v. 5 mA., 2 v. 2 a.	39/6

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/6
Small Pentode, 5,000Ω to 3Ω	3/9
Small Pentode, 8,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	4/9
Multi-ratio 40 mA., 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull	5/6
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω	16/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts to match 6L6, etc., to 3Ω or 15Ω Speaker	22/9
Push-Pull 20 Watts, high-quality sectionally wound, 6L6, KT66, etc., to 3, 7.5, or 15Ω (secondary in 4 sections of 3.7Ω each)	39/6
Williamson type, exact to author's specification	85/-

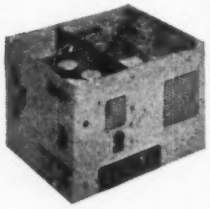
WE CAN QUOTE FOR QUANTITIES OF STANDARD OR SPECIAL TYPES. S.A.E., PLEASE, WITH ALL ENQUIRIES.

VALUE FOR MONEY OFFERS



AIR MINISTRY COMMUNICATION RECEIVER R1155A. Brand New in transit cases. Frequency ranges—18.5-7.5 Mc/s, 7.5-3 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s. Complete with 9 valves and Magic Eye. Guaranteed absolutely perfect. Price **£9/10/-**, plus 10/- for packing and carriage.

1155 POWER PACK AND OUTPUT STAGE complete with U50 and KT61 valves (not surplus) Black crackle case 12 x 8 x 5in. built-in 5in. pm Speaker and phone jack. 200-250v. A.C. All connections terminate in Jones plug which enables instant operation of receiver **without any modifications whatever.** Matches in appearance with receiver. Made to "Wireless World" specifications. Built entirely from top grade new components, **£7/10/-** plus 3/6 carriage.



G.E.C. VHF RECEIVERS complete with 10 valves. Ex-Govt. As used by police. Used but guaranteed in excellent condition. Valves comprise ZA2's, 954's or EF50's in HF and 1st Det. stages. Det 19 in local oscillator, KTW63's in three IF stages, D63 Det and AVC, LF H63, Output KT63, Noise suppressor D63, Power requirements 6v 3a, 270v 80ma, as used by various British Police forces. Available in TWO frequency ranges, "B" 95.5-100 Mc/s and "C" 78.5-82 Mc/s. Intermediate frequency adjustable 8.3-9.8 Mc/s. Oscillator Crystal controlled (No crystal included). Sensitivity 3 microvolts for 50mw audio output. Input impedance 72 ohms. Housed in Grey enamel steel case with lid 10 x 8 x 7in. Weight 22lbs. Note the amazingly low price, **49/6** plus 5/- carr.

GAUMONT BRITISH 16 mm. L516 TALKIE PROJECTOR. Absolutely complete and in very fine condition. Cost £216. A snip at **£75.** carr. paid.

NATIONAL NC46 HF RECEIVER. This is one of the latest National receivers. 10 valves. Coverage .6 to 30 Mc/s. with separate Band Spread scale. Grey crackle cabinet, L. 17½in., D. 9½in., W. 11in. Complete with National Speaker in separate grey crackle cabinet to match. 110v. We supply suitable stepdown transformer for 230v. An opportunity to secure a rare and much sought after receiver, **£35,** carriage paid.

BC221 FREQUENCY METER, complete with charts. Not in original cabinet. Cabinet fitted is actual size of BC221 front panel. Perfect condition. Separate R.A.F. type HT unit included. Price **111 gns.** A snip. **CATHODE RAY TUBES.** VCR138, 3½in. white screen, **3 gns.** 5NP1, **60/-.** 3BP1, **2 gns.** All postage paid.

VIEWMASTER TELEVISION COMPONENTS

If you are building the Viewmaster you cannot do better than order your parts from us. We hold very large stocks of all Components.

TCC Condensers, Midland or Holme Moss Kit	147/-	WB200 Video Chassis ...	18/6
Or separately as required.		WB102 Time Base, Power	18/6
Resistor Kit	35/3	WB101 Chassis Support	6/-
Wearite Coil Kit	30/-	WB103 Heater Trans. ...	42/-
Westinghouse Rectifier Kit	69/-	WB103A Auto Trans....	52/6
Bulgin No. 7 Kit	14/-	WB104 Mains Choke ...	15/6
Belling Lee L707 Kit	8/9	WB106 Frame Trans. ...	25/6
Colvern Pot. Kit	22/3	WB107 Line Trans.	32/6
WB112 Front and Rear Tube Supports, 9in., 21/-; 12in. ...	21/6	WB108 Scanning Coil ...	33/3
Instructional Envelopes. State Area	7/6	WB108/9 Focus Rings ...	22/6
		WB110 Width Control	10/-
		WB111 Boost Choke ...	5/9

EXPORT ONLY

3,000 OXYGEN MASKS, 6D642 Type G. Brand new. All in original cartons.
3,000 Gauges for de Icer Black Bakelite case, 2½in. dia., 4 screw fitting. Calibrated 14-0 vacuum. 0-10 pressure. New condition. All cartoned.
40 American Aircraft Cabin Heaters. Type ABV-50D-H7-B, all brand new in original packing.
100 5U/546 Voltage Regulators. All brand new. Individually boxed.
36 10Q13003 Type 7H. Black bakelite case, 3½in. diam.

Many items previously advertised still available.

SATISFACTION IS UNCONDITIONALLY GUARANTEED BY US AND MONEY WILL BE REFUNDED IN FULL ON ANY GOODS RETURNED CARRIAGE PAID WITHIN 7 DAYS OF RECEIPT. CAN WE BE ANY FAIRER?

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RADIO TRADERS LTD.

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WHOLESALE, MANUFACTURERS' AND EXPORT ENQUIRIES ONLY

JONES PLUGS & SOCKETS —4, 6, 8, 10 and 12 WAY

EX. GOVT. CARBON BRUSHES—LARGE STOCKS

RESISTORS

HIGH STABILITY, close tolerances from 1% ¼, ½, 1 and 2 watts. All values up to 2 meg., including 8, 13 and 30 meg.
VITREOUS WIREWOUND. Large selection from 2 to 200 watts.
CARBON. ¼ watt to 5 watt. All popular values. Standard Car Suppressors, 15,000 ohms.

CAPACITORS

Block Paper, Silvered Mica, Mica, Tubular and Ceramic.

SWITCHES

TOGGLE, YAXLEY, OAK, ETC.

EPICYCLIC DRIVES

INDICATOR LAMP HOLDERS

Red, Green and Clear.

LAMINATIONS

RADIOMETAL 31, 39 and 40. Also many other types.

VOLUME CONTROLS

MORGANITE "H" type, "LH" type, "M" type and WIRE WOUND. Most values and popular makes in stock.

PLUGS AND SOCKETS

CINCH, PYE, JONES, BELLING & LEE, BULGIN, ETC.

TRIMMERS

Variable CERAMIC TRIMMERS. Capacities from 5 to 100 pF. Spindle and pre-set types. Also Philips trimmers and trimmer tools and many other types.

WIRES

ENAMELLED, SILK COVERED, REG. CELLULOSE and PUSH-BACK. Screened, Standard and P.V.C.

VALVE HOLDERS

Paxolin, Moulded and Ceramic. Large selection including all latest types.

Large selection of

INSTRUMENT & RADIO KNOBS

NUTS, BOLTS, WASHERS, P.K. SCREWS, RIVETS, EYELETS, SOLDER TAGS, GROMMETS, GLASS CARTRIDGE FUSES, BRASS TERMINALS, VARNISHED COTTON AND PLASTIC SLEEVING—various colours ½ mm.—30 mm., ETC. STOCKISTS of all CINCH COMPONENTS.

LARGE STOCKS OF EX-GOVERNMENT AIRCRAFT, RADIO AND ELECTRONIC COMPONENTS

All enquiries dealt with individually, but regret no lists are issued.

IMMEDIATE DELIVERY

TRADE COUNTER OPEN 9.30 to 5.30 MONDAY TO FRIDAY. CALLERS WELCOMED.

For Quality Bargains Always—
Best Buy at BRITAIN'S

TEST EQUIPMENT

Signal Generators, Q Meters, Valve Volt Meters, Avo Meters, Triplett Test Meters, Valve Testers. All at knock-out prices for callers. Also in stock—62 Indicators, 62A Indicators, Type 6 Indicators, Pye Strips, Car Batteries, Metal Rectifiers, Chokes, Power Packs, Transformers, Mansbridge Condensers, 1154 Transmitters, and thousands of other first-class bargains.

LATEST ARRIVALS

RF UNITS TYPES 26 AND 27. These are the plug-in units for use with the R1355, in the "Inexpensive Television" circuit. Both these types have continuously variable tuning, and the valve line-up is R.F.—EF54, Mixer—EF54, Osc.—EC52. The frequency ranges are—Type 26, 50-65 Mc/s., thus covering Holme Moss Vision, Sutton Coldfield Vision and Sound, Kirk o' Shotts Vision and Sound and Wenvoe Sound, directly without any modifications. Can easily be altered to all 5 stations. Type 27 covers 65-85 Mc/s. —Wenvoe Vision and can also be easily converted. The output of these converters is 7.5 Mc/s. and can be fed directly into any receiver covering this frequency. BRAND NEW AND BOXED, either type, **59/6**, post paid.

R3118 RESPONSER UNIT. A 15-valve 1½-metre superhet for A.C. mains 200-250 volts 50 cycles. This unit would be extremely suitable for alteration to T.V. or the Wrotham F.M. transmission. Contains 2—EF54, 1—EC52, 6—SP61, 1—P61, 1—5Z4G, 3—VR92 and 1—Y63 and power pack. Note the price of ONLY **79/6**, plus 7/6 carriage. A REAL BARGAIN.

ROTARY CONVERTERS. 24-volt D.C. input, output 230 volts 50 cycles at 100 watts. The rotary unit is contained in a grey steel case with carrying handle and is fitted with standard three-pin mains output socket. Price **92/6** each. We also have 12-volt rotary converters (rotary only) 230 volt 50 cycle, output 100 watts, Price **102/6**.

182A INDICATOR UNIT contains three EF50's, one 5U4G, four SP61's and a 6½in. Cathode ray tube, VCR517. This tube will replace the VCR97 without any alteration, is completely free from cut-off and has a more pleasant tube colour. The unit contains in addition a very large assortment of pots., resistors, condensers, etc. All tubes demonstrated to personal shoppers. This is the very best value obtainable to-day. Supplied **brand new** (less relay) for only **79/6**, plus 7/6 carriage, in original transit case.

MINIATURE MAINS TRANSFORMER.—Primary 230 volts 50 cycles. Secondary 230-0-230 volts 50 mA, 6.3 volts 2.6 amps. Suitable for small sets, instruments, etc. Upright mounting, size 2½in. x 2½in. x 3in. high. Price ONLY **10/-**, plus 1/- post. Brand new and boxed.

STANDARD MAINS TRANSFORMER. 200/230/250 volts 50 cycles. Secondary 325-0-325 volts 70 mA., 6.3 volts 2.5 amps, 5 volts, 2 amps. Half shrouded, drop through with mains panel. Size 4in. x 3½in. Brand new at **12/6**, plus 1/6 post.

R1294 RECEIVER.—This superhet receiver covers 10 to 60 cms. with continuous variable tuning. Local osc. E1231 with silicon crystal as first detector. I.F. of 13.5 Mc/s. Complete with all 9 valves and instruction manual. Price **£14**, plus £1 carriage and packing.

HRO POWER SUPPLY operates from a 6 volt D.C. source and supplies 165 volts at 80 mA. completely smoothed D.C. Uses Mallory Type 626 vibrator and 6X5 rectifier, 17 Henry smoothing choke, hash filter, etc. This is a really well made job, typical of the manufacturers of the HRO. Contained in a black crackle cabinet size 7in. x 7½in. x 6in. high. Supplied BRAND NEW in original packing for only **52/6**.

RCA SPEAKER.—An 8in. P.M. unit contained in beautiful black crackle cabinet, suitable for AR88, etc. BRAND NEW, price only **45/-**, plus 2/6 carriage.

SPECIAL ROTARY GENERATOR. Output 80 volts, 2,000 cycles. Input 80 volts D C. These units are complete with voltage regulator and are 500 watt rating. Suitable for powering majority of ex-surplus equipment. **Enquiries welcomed.**

COMMUNICATION RECEIVER R1155 for world-wide reception. This set is recognised as one of the finest obtainable. For those not familiar with the receiver we can supply the authoritative "Wireless World" circuit and descriptive booklet for 1/3 post paid. All our receivers are air-tested before despatch and supplied complete with 10 valves. ABSOLUTELY BRAND NEW for **£11/19/6**, plus 10/6 carriage and packing, in original transit case. Demonstration given any time. Come and hear the receiver you buy.
Few only, slightly used, air tested at **£7/19/6**, plus 10/6 carriage, in original transit cases.

R1155N. A few of these models still available at **£17/19/6**, plus 10/6 carriage and case.

A.C. MAINS POWER PACK/OUTPUT STAGE enables the R1155 to be operated from 200/250 volts A.C. mains without any alteration whatever to the receiver. Just plug into mains and connect 2/3 ohm speaker (speaker not included). Manufactured by ourselves from first class components in a black case size 8½in. x 6½in. x 4in. Uses extra heavy duty transformer, 5Z4, 6V6 and output trans. Note that OUR power pack is GUARANTEED for SIX MONTHS. Complete with all valves, Jones plugs and leads for **£4/10/-**, plus 3/6 carriage.

SAVE £ £ £

We offer brand new R1155, Power Pack/Output stage for only £15/19/6, plus 12/6 carriage (not model "N").

RECEIVER TYPE R1132A.—A complete U.H.F. receiver covering 100-124 Mc/s. with variable tuning. In handsome case, suitable for rack mounting, size 19in. x 10½in. x 11in. All normal controls, L.F. Gain, R.F. Gain, B.F.O., 0, 6 and 12dB attenuator and tuning meter. Tuning by means of a super slow motion drive with clear 0-100 dial. Valve line-up—R.F.—VR65, F.C.—VR65, Oss.—VR66, Stabilizer—VS70, 2 I.F.'s—VR53, B.F.O. VR53, I.F Amp.—VR53, Det.—VR54, A.F.—VR57, Output—VR67. Power requirements are 6.3 volts 3.3 Amps and 250 volts at 100 mA. Coils easily altered for 144 Mc/s. or for reception of Wrotham on 90 Mc/s. **Brand New** and unused complete with circuit diagram for only **79/6**. Jones plug supplied free. Plus 10/6 carriage and packed in original transit case.

TYPE 3 POWER PACK. For callers only, we have a few of the rack-mounting power packs for the above receivers. These are Brand New.

RF UNITS for the R1355 supplied modified to T.V. frequency required. Any station, sound or vision for **32/6**, plus 2/6 carriage.

G.E.C. OSCILLOSCOPE as advertised last month. A few still available for only **£9/19/6** plus 4/6 carriage. Send S.A.E. for full particulars.

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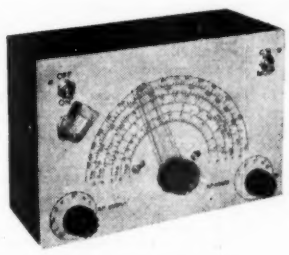

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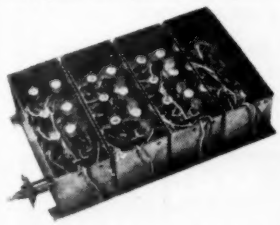

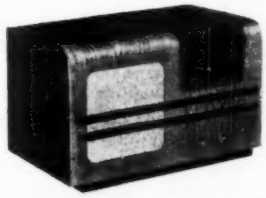

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R1355 receivers as specified for the inexpensive televisor, 11 valves, new, 55/-, carr. 5/-.—Smith, Highworth Rd., Faringdon, Berks. [9542

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [0065

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RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

£9—New R1155 receivers.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [9293

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A.D.C., £16; Barker 148, £10; Lowther tuner LES, £18; amp, B.S.F., £14; T.C. B.T 3, £6; offers.—Pearson, Coupe Green, Hoghton, Preston. [9536

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LOUDSPEAKERS—SURPLUS AND SECONDHAND WANTED

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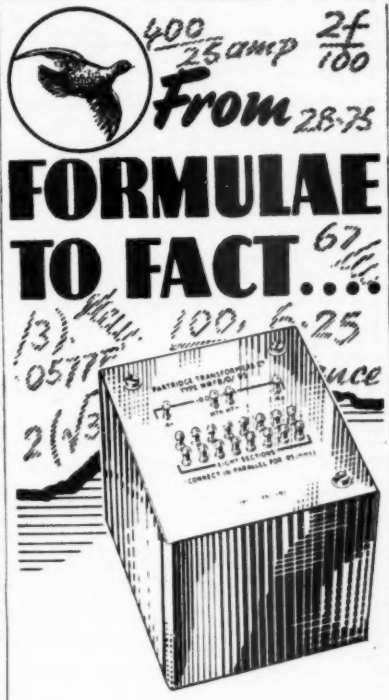

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TEST EQUIPMENT—SURPLUS AND SECONDHAND

COSSOR Double Beam Oscilloscope model 339, complete with spare single beam tube (blue trace), instrument has had very little use, £35; Cossor Ganging Oscillator model 343 (a beat frequency type frequency modulated H.F. signal generator, range 20 Mcs to 60 Kcs), both with instruction manuals, used few hours only, £20, or the two £50; returnable illustration, 5/6; AVO electronic test meter, 4 hours' use, with instruction manual, £25 or near offer. See our displayed advertisement on page 118.—Radio Exchange Co., 14, St. Mary's St., Bedford. [0148

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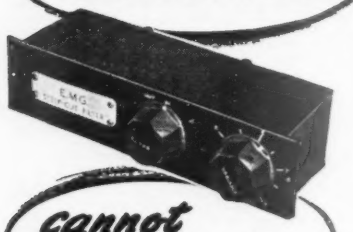

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TEST sets: IE19A, TS34, TS10A/APN, TS238; Du-Mont oscilloscopes, types 168 and 208, also oil-filled electrostatic condenser, 225UF, 25,000 volts D.C.; also H.F. alternators, 80 volts, 25 amps, 1,500 c.p.s.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [9292

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ALL types audio and carrier telephony filters made to order.
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MIDLAND Radio Coil Products, 28, Winstanley Rd., Wellingborough. [0223

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SHOP soiled tape recorders in new condition. Simon 1a £65, Simon 2b £48; also Connoisseur single speed turntable and pick-up, £18; amplifier for above turntable, 15 watt, £16; demonstrations anywhere in London.—Larkswood 1658. [9550

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ASSEMBLY, wiring, special equipt.; audio specialist; private or trade.—Radiovizier, 377, High Rd., N.2. [0219

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COMPONENTS: our 1953 catalogue is now available, giving full details of our comprehensive range of components.—Watts Radio, 8, Baker St., Weybridge, Surrey. [9493

TV.—Coil sets for EE, PW, VM, TK receivers from 18/6. ¾in square×1¼in canned, cored, tagged formers, 2/3; ¾ polyformers, 12/- doz. —Bel Sound Products Co., Marlborough Yard, N.19. Tel. Arc. 5078. [0186

CRYSTAL microphone inserts (Cosmocord Mic--6), guaranteed brand new, 15/6 post free; Cosmocord Mic—30, hand stand microphones, black or white, £4/4 each, post free.—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford. [0036

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EARLY CLOSING DAY THURSDAY

EX-NAVAL ROTARY CONVERTERS, 110 volts D.C. input, output 230 volts A.C. 50 cycles, 1 phase, 250 watts capable of 50% overload, weight 100 lb., price **£10/10/-** each, carriage forward.

ROTARY CONVERTERS, 24-28 volts D.C. input 1,200 volts 70 m/amps, D.C. output, **10/-** each, P.F.

MAINS TRANSFORMERS (NEW), input 200/250 volts in steps of 10 volts, output 350/0/350 volts 300 m/amps, 6.3 volts 8 amps twice, 4 volts 4 amps, 5 volts 4 amps, **70/-** each, carriage 3/6; ditto, 450/0/450 volts 250 m/amps, 6.3 volts 8 amps twice, 4 volts 4 amps, 5 volts 4 amps, **7£/-** each, carriage 3/6; another, input as above, output 500/0/500 volts 250 m/amps, 6.3 volts 8 amps twice, 6.3 volts 4 amps, 4 volts 4 amps, 5 volts 4 amps, **75/-**, carriage 3/6. Another, wound to (electronic) specifications, 350/0/350 volts 250 m/amps, 4 volts 8 amps, 4 volts 4 amps, 6.3 volts 8 amps, 0/2/6.3 volts 2 amps, **70/-** each, carriage paid; another, input as above, output 500/350/0/350/500 volts 250 m/amps, 6.3 volts 6 amps, 0/2/6.3 volts 2 amps, 0/4/5 volts 4 amps twice, **75/-** each, carr. 3/6.

MAINS TRANSFORMERS (NEW), suitable for spot welding, input 200/250 volts, in steps of 10 volts, output suitably tapped for a combination of either 2/4/6/8/10 or 12 volts 50/70 amps, **95/-** each, carriage 7/6.

MAINS TRANSFORMERS (NEW), 200, 250 volts input, in steps of 10 volts, output/ 0, 6, 12, 24 volts 6 amps, **42/6** each, post 1/6. Another as above but 10-12 amps, **55/-** each, post 1/6; another, as above but 25/30 amps, **75/-** each, carriage 3/6; another, input as above, output 0/18/30/36 volts 6 amps, **47/6** each, post 1/6.

EX-RADAR MAINS TRANSFORMERS, 230 volts input 50 cycles 1 phase, output 4,500/5,000 volts approx. 80 m/amps, 6.3 volts 2 amps, 4 volts 1½ amps, 2 volts 2 amps, these transformers are new, immersed in oil, can be taken out of the oil and used as television transformers giving output of 10 m/amps, overall size of transformers separately, 5½in. × 4½in. × 4in. and 3in. × 3in. × 2½in., price **75/-** each, carriage paid.

MAINS TRANSFORMERS (NEW), input 200/250 volts in steps of 10 volts, output 350/0/350 volts 180 m/amps, 4 volts 4 amps, 5 volts 3 amps, 6.3 volts 4 amps, **45/-** each, post 1/6; another 350/0/350 volts 180 m/amps, 6.3 volts 8 amps, 0/4/5 volts 4 amps, **45/-** each, post 1/6; another 500/0/500 volts 150 amps, 4 volts 4 amps C.T., 6.3 volts 4 amps, C.T., 5 volts 3 amps, **47/6** each, post 1/6; another 425/0/425 volts 160 m/amps, 6.3 volts 4 amps, C.T. twice 5 volts 3 amps, **47/6** each, post 1/6.

MAINS TRANSFORMERS (By well-known makers). Input 100 & 230 volts, output 6 volts 1½ amps twice, price **7/6** each, post 1/-; another 200/250 input, output 25 volt 4 amps C.T., **25/-** each, carriage 1/6.

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AUTO WOUND VOLTAGE CHANGER TRANSFORMERS, tapped 0/110/200/230 volts 350 watts, **55/-** each, post 1/6; as above, but 500 watts, **70/-** each, carriage 3/6; as above, 200 watts, **40/-** each, post 1/6.

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MALDEN TRANSFORMER SUPPLIES offers 80W fluorescent chokes, 230v with circuit, 17/6; glow starters, 2/6; 6 and 12v metal rectifiers, 2 amp, 8/6, ½ wave, 250v 300 mill-amp, 13/6, supplied to any specification; ex-Government safety heaters 230v 350W, 12/6; rotary converters, 12v or 24v d.c. input and giving 250v 60 mill-amp and 6.3v at 2.5 amp, 6/8; speaker cases, 5in. bakelite, 5/8.—200, Cambridge Rd., Kingston-on-Thames. Kin. 5501. [0038

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P. B. CRAWSHAY, 166, Pixmore Way, Letchworth, Herts.
VOLTAGE Regulators, Ferranti 230v motor-driven moving coil, 480va, £18; 1,440va, £28.
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METADYNE Generators, 45v 60a, £28.
METADYNE Motors, 1½hp, £15.
AMPLIDYNE Motor Generators, in 78/110v d.c., out 250v 1a, £7.
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ROTARY Converters, in 24v d.c., out 80v, 1,200c, 6.25a, £5.
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ALL-WAVE superhet midget, world-famed maker, ivory plastic; £9/19/6 guaranteed.
VALVES: VR108 (SP13C), 3/11; VT171 (DK92), VT172 (DAF91), VT173 (DF91), VT174 (DL92), 11/6; VU39 (MU12/14), 9/6; CV509 (6V6), 10/6; 500 other types available; s.a.e. for lists; trade enquiries invited; 9-6 week-days, 9-1 Saturdays. [0237

MAGSLIPS at 1/10 to 1/20 of list prices, huge stocks, please state requirements.
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EDE'S STUDIOS, 274, Haydons Rd., London, S.W.19. Tel. Liberty 5327. Send for our latest list of radio components. Below are few random items.
TUBULAR electrolytic condensers, wire-ended, fresh stock; 500v Wkg. 8mf 3/-, 16 mf 4/6, 32mf 6/-, 16-16 mf 6/-, 8-8 mf 5/6, 8-16 can 5/-.
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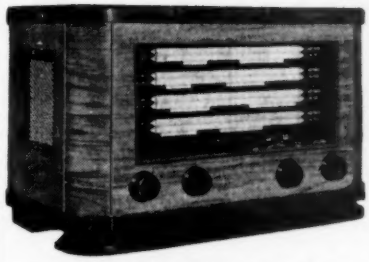
Armstrong



THE CABINET MODEL
BS 54

SPECIFICATION

SUPPLY : 110 and 200-250 volts A.C. Mains

WAVE RANGE : 10.9—50 metres

SIZE :
Chassis, 13″ × 7½″ × 8″
Cabinet, 16″ × 10″ × 8″

4 WATTS OF AUDIO

VALVES : 6K8, 6K7, 6Q7, 6V6, 6X5

Model BS54 is housed in an attractive walnut cabinet complete with high-quality P.M. loudspeaker. Negative feed-back is incorporated in the output stage, making the receiver capable of first-class reproduction. Valves of the International Octal type are used throughout so that, if necessary, replacements can be secured in any part of the world.

For the convenience of customers who are unable to call during normal working hours, we are now open until 5 p.m. on Saturdays.

MODEL EXP 125/3 14-VALVE ALL-WAVE RADIOGRAM CHASSIS

5 Wave Bands covering from 10.9 to 550m and 800m to 2,000. R.F. Pre-Amplifier. Two I.F. Stages with Variable Selectivity. Bass and Treble Controls. 15-Watt Push-Pull Output. For A.C. Mains. **£36.15.0,** plus P.T.

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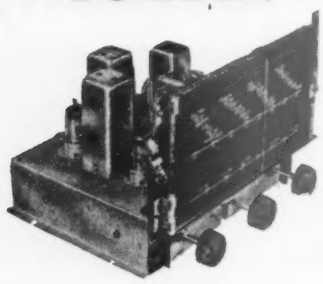

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BRIDGE CONNECTED FULL WAVE. 17 v. 1.2 a., 16/4; 1.6 a., 26/-; 2.5 a., 29/-; 3 a., 30/-; 4 a., 34/6; 5 a., 37/6, all post free. 33 v. 0.7 a., 24/3; 1 a., 28/-; 1.5 a., 45/-; 2 a., 51/-; 3 a., 52/-; 4 a., 62/-; 5 a., 67/-; all post 1/-. 54 v. 1 a., 38/6; 1.5 a., 62/-; 2 a., 69/-; 3 a., 70/-; 5 a., 93/-; 72 v. 1.5 a., 78/-; 2 a., 81/-; 3 a., 92/-; 5 a., 122/-; 100 v. 1.5 a., 112/-; 2 a., 128/-; 5 a., 174/-; all post 1/2.

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SMASHING bargains in P.M. speakers: Elac 10in P.M. 2-3ohm V/coil, less trans., to handle 5 watts; our price, 27/6.

ALSO the famous Goodmans 10in P.M. 2-3ohm V/coil, less trans., with flared cone and light-weight construction; cannot be beaten at 22/6 each.

SEASONAL offer!! Manufacturer's surplus a.c. mains amplifiers, 4watts output, complete with matched 10in M/Eng. speaker, supplied with leads and fitted with P/U sockets, all tested before dispatch, ideal for records and the cheapest in London; our price, £5/15, inc. pack/post.

LOOK!! Mains trans. by Parmeko, universal fixing, primary tapped, 0-200-220-240v, sec. 290-0-290v 80ma., 6.3v 3a and 6.3v tapped at 4v, with screen; our price, 14/11, plus 1/- post/packing.

MORE wonderful value!! 1meg or ½meg V/controls with L/spindle and D/P switch, 3/- each; 2meg 100K/ohms, 25K/ohms and 5K/ohms, with S/P switch, 2/3 each.

WESTINGHOUSE type metal rec., 250v R.M.S. 65ma.; 5/6 each.

TWIN balanced feeder 80ohm for television; 4d per yard.

A.R.P. dual wave coils for L/M waves with circuit, 6/6 pair.

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METAL can electrolytic cond., 64+120mfd, 350v, 425v surge, 12/6 each; 16+32mfd, 350v, 4/9 each; 16+8mfd, 450v, small type, 4/11; cardboard wire end bias cond., 50mfd, 50v, 9d each.

MANY other lines in television and radio components always in stock at bargain prices.

TERMS, c.w.o., no c.o.d.; send 9d extra for postage orders under £5; 2½d s.a.e. all enquiries and list. [0021

G.E.C. 7-watt VHF mobile transmitter/receivers, complete with 12v rotary power pack 80.9, 81.1, 81.3 mc/s, new; £37/10 each.

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G.E.C. single channel V.H.F. transmitter/receiver, Cat. No. B.R.T.600; special offer semi-shrouded mains trans. 250/0/250 60ma, 5v 2amp. 6.3v, 4amp. 13/3 each; communication receivers in stock, Hammerlund Super Pro, H.R.O. Seniors, C.R.100, A.R.88D., A.R.88L.F., etc., all in perfect order; R.1155 receivers in new condition; your enquiries are invited for rotary convertors and electric motors, most sizes and type available from stock; special clearance of F.H.P. electric motors, 35/-; 110v 250v a.c.

UNIVERSAL a.c./d.c. motors, suitable for sewing machines, 47/6 each; 12v-15v a.c./d.c. motors with extended spindle, suitable for models, etc., 9/3; 20-watt P.A. rack mounting amplifier, new and complete, with heavy duty a.c. power pack, 200/250 PX25 P.P. output, £5/10, less valves; new moving coil microphones, hand type, heavy duty and complete with 12yd screened cable, £3/15; 20ft telescopic tubular T/V mast, 18/6 each; large selection of test equipment; multi-range meters, valve testers, signal generators, oscilloscopes, bridge meggers and meggers, etc., all at reasonable prices; hand bearing prismatic compasses, perfect, 45/- each; very large stocks of transmitting valves, Klystron, of all types; send us your requirements; special offer of new, not ex-W.D., mains transformer, semi-shrouded 200/250v tapped primary, 250-0-250, 100ma, 5v 3amp, 6v 4amp, 21/6 each; large stocks of L.T. transformers, special sizes and ratings wound to specification; auto-record changers in stock from £13/2/6 to £18/10; switchboard mounting volt meters, ampmeters, various ranges a.c. and d.c. available at cheap prices to clear; large stocks of enamelled wire, 18 and 20 s.w.g., D.S.G. Special offer, H.R.O. coils, 48-96 m/s and 180/430 k/s, 45/- each; quantity of litz and nickel chrome wire available; Hallicrafter Super Skyrider SX28 in stock; Evershed bridge megger, 500v 1½kw e.d.c.; rotary converter, 220 d.c./230 a.c., complete with Igranic starter, £28; large selection of American Pyranch high-voltage working condensers; 5m/a meter rectifiers, 6/3 ea.

HAMMERLUND B.C. 779B, perfect order, rack mounting £42/10; Q-Max, Q-5/10 receiver, new £38; prices do not include postage.

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LOOK!—Plan position indicators containing 17 valves—2 VT60A (807), KTZ41, 2 DDL4, MH4, VR78, 7 VR65A, HVR2, 2 UU4, large 230/150 power pack giving 300/0/300v (twice), 6.3v, 2/0.2a, 4v (twice), 4,000v EHT (approx.), M type motor with reduction gearing (worm and spur), scanning coils with slip-rings, large quantity of other parts, including 22 toroidal, WW, and other pots, 24 Mansbridge condensers (1-10mfd 450v and others up to 5,000v), switches, 8 knobs (fluted), 14 jacks, fuses micro-switch, dial light, 70 vitreous and other resistances and condensers, etc.; the whole mounted in handsome heavy gauge steel cabinet, 20½in×27in×60in high, finished in black, with hinged doors and plated handles; price (unused), £8/15 each carr. paid (cabinet alone worth more).—K. M. Logan, Westally, Hitchin, Herts. [0238

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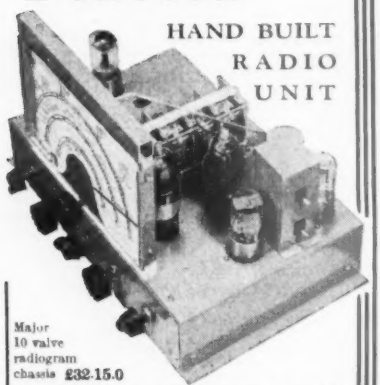

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TC75. 30 H. 20 mA., 500 ohms		10	6
TC76. 10 H. 150 mA. 150 ohms	£1	3	3
TC38. 5 H. 250 mA. 50 ohms	£1	4	9
LF60. 10 H. 60 mA. 400 ohms		7	11
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WANTED, small quantity of Velodyne motors in good condition. W.D. ref., Type 74, Ref. No. 10KB/954.—Nuffield Institute, Oxford. [9471

WANTED, HRO coils, Rxs, etc., A.R.88s, BC348s S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

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WANTED.—BC-610 Hallicrafters, RCA ET-4336 transmitters, SX-28, AR-88, S-27 HRO receiver and spare parts for above; best prices.—P.C.A. Radio, The Arches, Cambridge Grove, W.6. [0081

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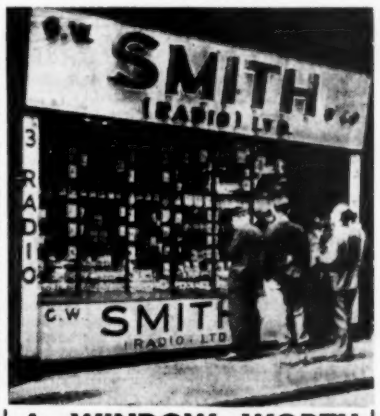

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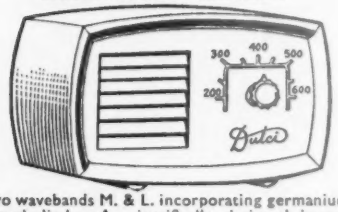

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24	1	,,	13 6
12	10	,,	£2 0 0
12	6	,,	£1 5 0
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12	2½	,,	16 6
12	2	,,	12 0
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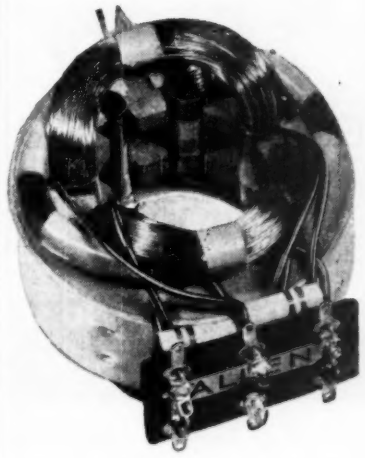

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ENGLISH ELECTRIC Co., Ltd., Luton, have a vacancy for an electronic engineer with drawing office experience, capable of translating laboratory ideas into engineered equipment; H.N.C. or equivalent an advantage but not essential; salary in range £500-£650 according to qualifications and experience.—Please reply quoting Ref. 1071 to Central Personnel Services, English Electric Co., 336/7, Strand, W.C.2. [9537

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A MANUFACTURER of television receivers in the North-West requires the services of a television design engineer experienced in modern circuit techniques, and able to initiate and carry out simple development projects; candidates should be between 25 and 35 years of age, and should have a University Degree or equivalent qualification; the post is permanent and pensionable and arrangements will be made to house the successful applicant; please reply quoting reference CIH to—Box 4357. [9496

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DEVELOPMENT Engineers are required by the Electronics Division of Murphy Radio, Ltd., to work with a subsidiary Company at Ruislip, Middlesex; the work may be in the general field of electronics but special projects require personnel to work on ground and airborne aerial systems and telemetry; applicants should write in the first instance quoting "Engineers, Ruislip" giving full particulars of their experience and qualifications to—Personnel Department, Murphy Radio, Ltd., Welwyn Garden City. [9481

MURPHY RADIO invite applications for posts as Development Engineers in their electronics division. Applicants should have degrees in engineering or physics or equivalent qualifications preferably with some industrial experience and should be capable of undertaking original development work and of leading a design team. Reasonable prospects of housing for London applicants. Employment is permanent and pensionable and offers excellent opportunity of broadening experience. Applications giving full details of experience and qualifications may be forwarded in confidence to Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [9524

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, require for work on guided weapons and like projects, development engineers, senior development engineers, mechanical and electronic, for their development laboratories; fields include microwave and pulse applications; salary range £400-£1,250 per annum; vacancies also exist for specialist engineers in component design, valve applications, electro-mechanical devices and small mechanisms; the company's laboratories provide excellent working conditions with social and welfare facilities; superannuation scheme, assistance with housing in special cases, apply by letter stating age and experience, to—The Personnel Manager (Ref. CHC). [0239

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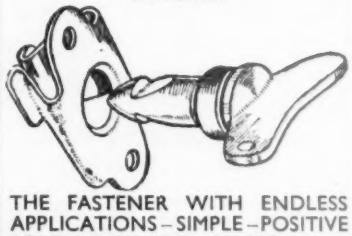

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NELSON Research Laboratories, The English Electric Co., Ltd., Stafford, require a man to undertake the calibration and standardisation of electrical instruments, high frequency equipment and temperature measuring equipment. PREVIOUS experience of instrument calibration (other than house service meters) is essential; there will be scope in this vacancy for a keen and competent man to extend facilities and develop methods and equipment.—Please reply, quoting reference 1072, to Central Personnel Services, The English Electric Co., Ltd., 336-7 Strand, London, W.C.2. [9552

MINISTRY of Supply, R.A.E., Farnborough, require experimental officer to co-ordinate technical data, development and approval of electronic valves for joint Services use; quals.: Higher School Cert (Science) or equiv., Degree, H.N.C. or equiv. in physics or electrical engineering may be an advantage; at least 2 years' experience on valve development essential; min. age 26; salary within range, £597-£754; women somewhat less; post unestablished.—Application forms from M.O.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting A.339/52/A; closing date Feb. 10, 1953. [9532

MURPHY RADIO have vacancies in their electronics division for a first-class Senior Design Draughtsman and a Senior Mechanical Designer. Applicants should be up to at least National Certificate standard and have had experience in design of electronic equipment, small mechanisms or similar work and must be capable of working on their own initiative. Reasonable prospects of housing for London applicants. Employment is permanent and pensionable and offers excellent opportunity of broadening experience in this interesting field of work. Full details of experience and qualifications should be included in applications which may be forwarded in confidence to Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [9523

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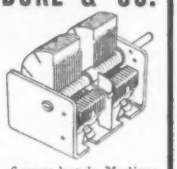

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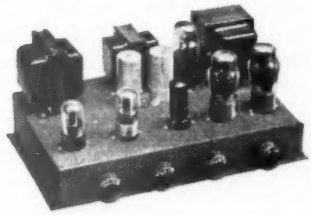

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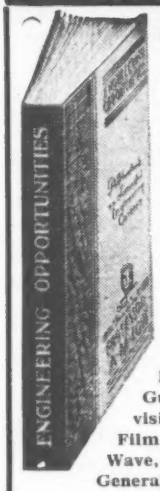

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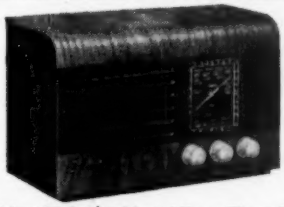

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100	350	400	450	2¾	1⅜	CE 10 LE	13/6
200	,,	,,	770	4½	1⅛	CE 36 LE	24/-
60 - 100	,,	,,	450	4½	1⅜	CE 37 LEA	21/-
60 - 100	,,	,,	500	4½	1½	CE 36 LEB	23/-
64 - 120	,,	,,	530	4½	1¾	CE 60 LE	24/-
60 - 250	,,	,,	500	4½	1¾	CE 60 LEB	34/-
100 - 100	,,	,,	550	4½	1½	CE 36 LEA	26/-
100 - 200	,,	,,	700	4½	1¾	CE 60 LEA	33/-
100 - 200	,,	,,	700	4½	2	CE 15 LE	34/-
60	450	550	450	3¼	1⅜	CE 38 PE	14/-
60 - 100	,,	,,	500	4½	1¼	CE 60 PE	29/-

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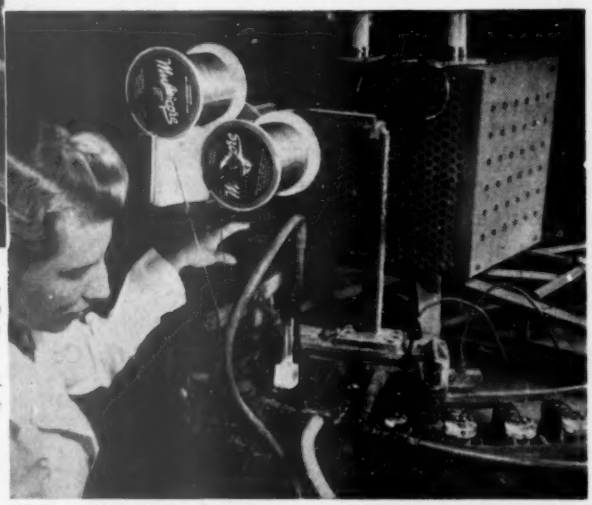
prefers ERSIN MULTICORE SOLDER

The Finest Cored Solder in the World

(ABOVE) **RADIO AND TELEVISION.** *Ersin Multicore Solder is used exclusively by the Ferguson Radio Corporation, Enfield, Middlesex. 60/40 Alloy 16 s.w.g. is shown here being used in the final assembly of the main chassis of the Ferguson 16" Television console 989.*

(RIGHT) **ELECTRIC LAMPS.** *At the Atlas Lamp Works, Edmonton. Ersin Multicore Solder in 20/80 alloy 16 s.w.g. is used for the soldering of end caps on standard BC electric lamps. This machine is capable of capping and soldering 3,000 lamps per day.*



FOR FACTORY USE

Ersin Multicore Solder is made as standard for factory use in 6 alloys and 9 gauges, and is supplied in nominal 7-lb reels. Other alloys and gauges can be supplied to special order. Bulk prices on application.

FOR RADIO ENTHUSIASTS & SERVICE ENGINEERS

ERSIN MULTICORE SOLDER is made in 4 specifications for radio and electrical use.

SIZE 1—5/- CARTONS (SUBJECT)

Catalogue Ref. No.	Alloy Tin/Lead	S.W.G.	Approx. Length per carton
C. 16014	60/40	14	18 feet
C. 16018	60/40	18	47 feet
C. 14013	40/60	13	16 feet
C. 14016	40/60	16	34 feet

COMSOL ALLOY. Ersin Multicore Solder is now available in Comsol Alloy having a melting point of 206 C. This is 113°C. above the solidus melting point of the usual tin/lead alloys. Comsoi is a special soft silver solder and, by arrangement with Johnson Matthey & Co. Ltd., it is now being manufactured by Multicore Solders Ltd. in the form of Ersin Multicore Solder incorporating 3 cores of the well-known extra active non-corrosive Ersin flux.

NEW PUBLICATIONS. "Multicore Solders Technical Summary" ref. M52, showing complete details of all Multicore Solders products, packing specifications, etc. "Considerations of Soldering Technique in Radio and T.V. Assembly" ref. M53, being a transcription of a Paper delivered to the Australian I.R.E. in Sydney. Both the above publications are available free of charge to manufacturers. Radio enthusiasts are asked to enclose a stamped addressed envelope.

NEW PACK FOR TELEVISION ENGINEERS

An economy pack for Service Engineers and Workshops using fair quantities of solder. 1-lb. reel containing approximately 167 feet of 18 s.w.g. 50/50 alloy packed in an attractive yellow and black carton, cat. ref. R5018, 15/- each (subject).

MULTICORE WILL BE IN THE FOREFRONT OF THIS YEAR'S R.E.C.M.F. EXHIBITION. SEE US AT GROSVENOR HOUSE, APRIL 14th TO 18th.